Diamond Valley
Area Drainage Master Plan

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Yavapai County Flood Control District

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1. Project Area and Purpose

The Diamond Valley area has experienced flooding over the last several years. This overall area is made up of mostly of the Diamond Valley and Yavapai Hill subdivisions, with a small portion of the Ranch at Prescott subdivision upstream and a portion of Victorian Estates downstream. Areas contributing to storm runoff are in the City of Prescott, Prescott Valley, and unincorporated Yavapai County adjacent to State Route (SR) 69. The watershed drains south to north and west to east with main drainages crossing SR 69 at four locations. Alberson Wash, running along the southeast side of SR 69, drains the study area and is designated Zone AE with Floodway by FEMA. For the plan, only areas in unincorporated Yavapai County were considered. The vicinity, location and aerial maps can be found in Figure 1.1, Figure 1.2, and Figure 1.3.

The purpose of this report is to update flood hazard determinations for the Diamond Valley area using current methodologies for new hydrologic and hydraulic analyses. The results of these analyses were used to develop and prioritize flood mitigation projects for future funding considerations or grant opportunities. The flood mitigation projects will increase resiliency and help protect the public and property from flooding and flood related damages. This report contains descriptions of the engineering approach and the technical data to support the plan development.

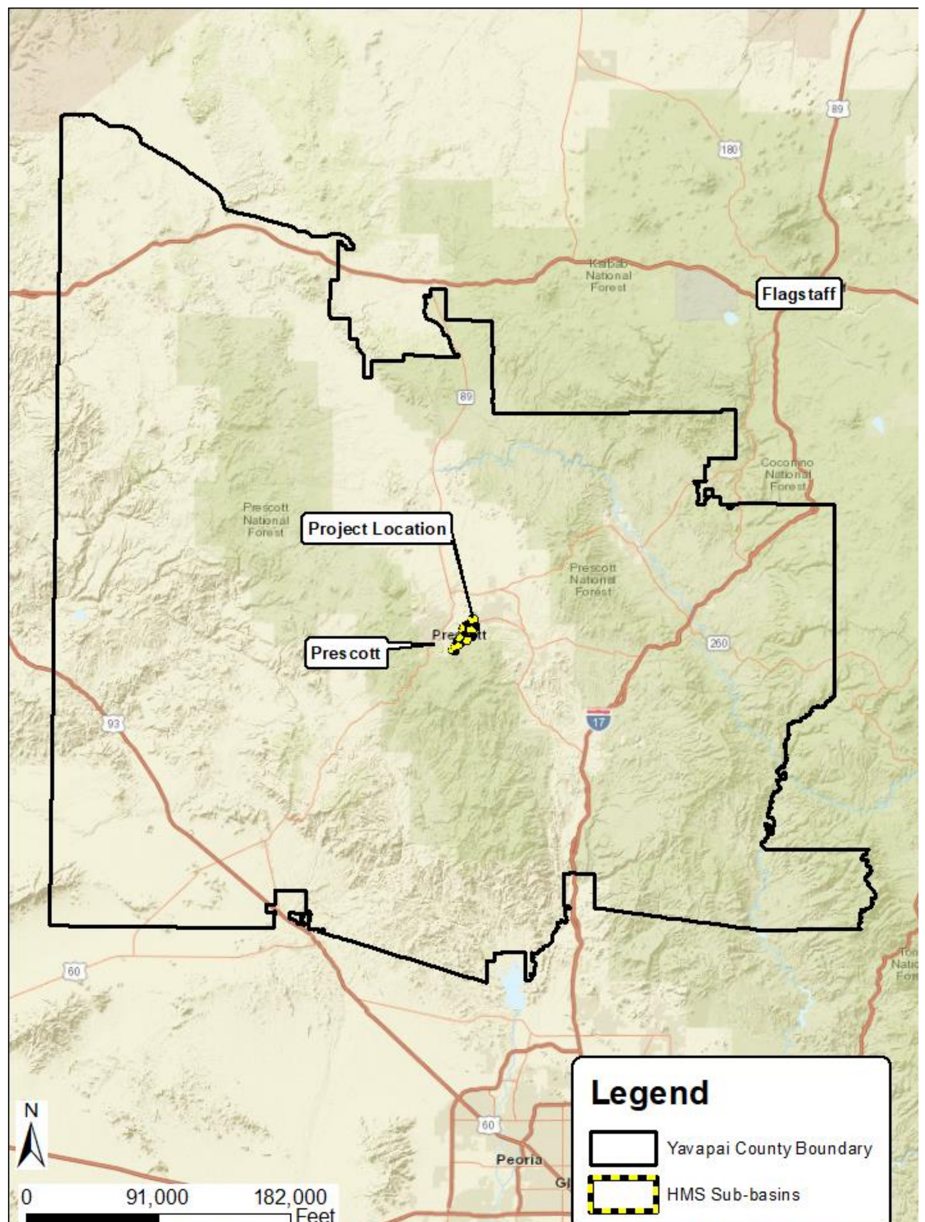


Figure 1.1: Vicinity Map

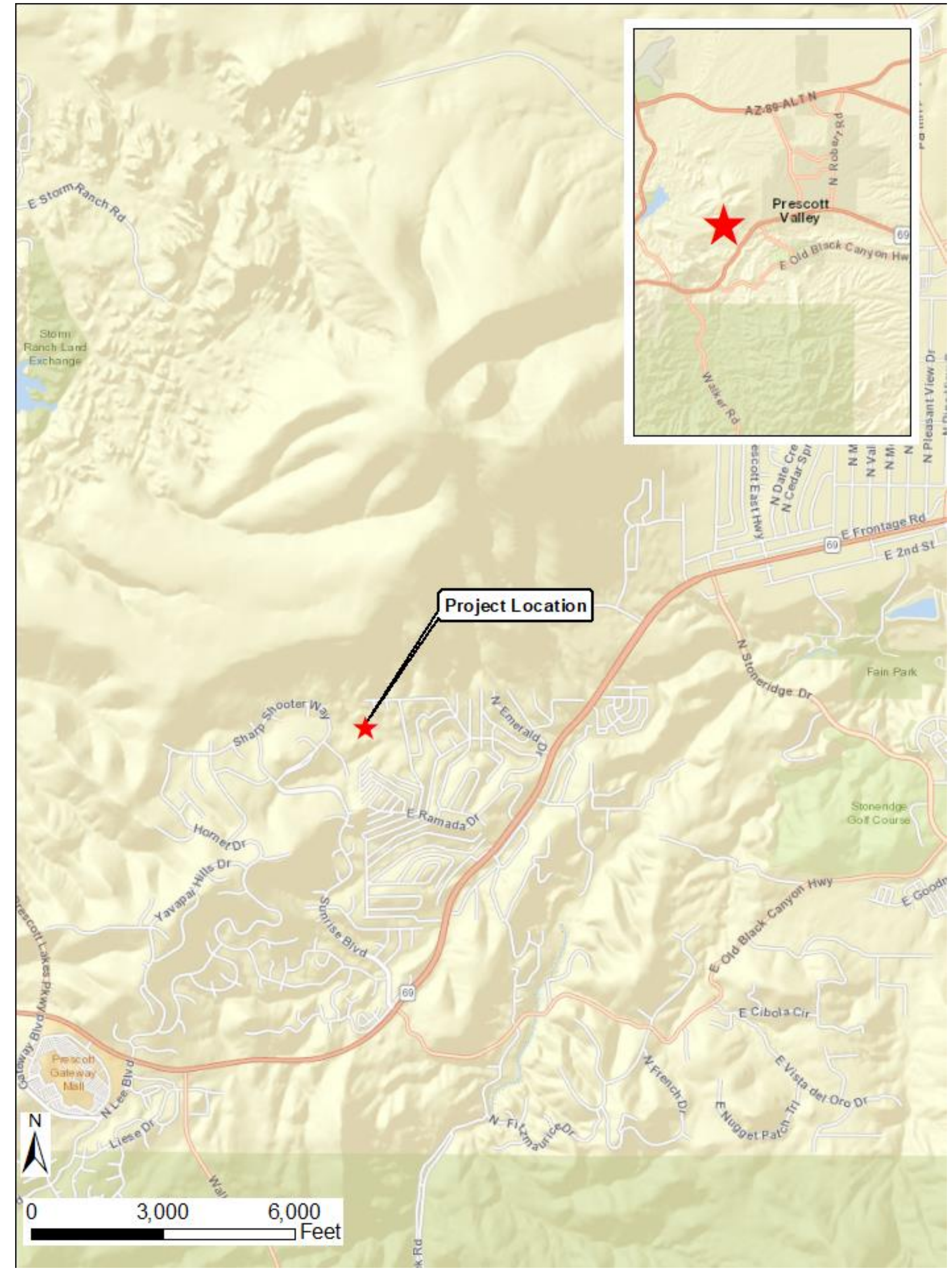


Figure 1.2: Location Map

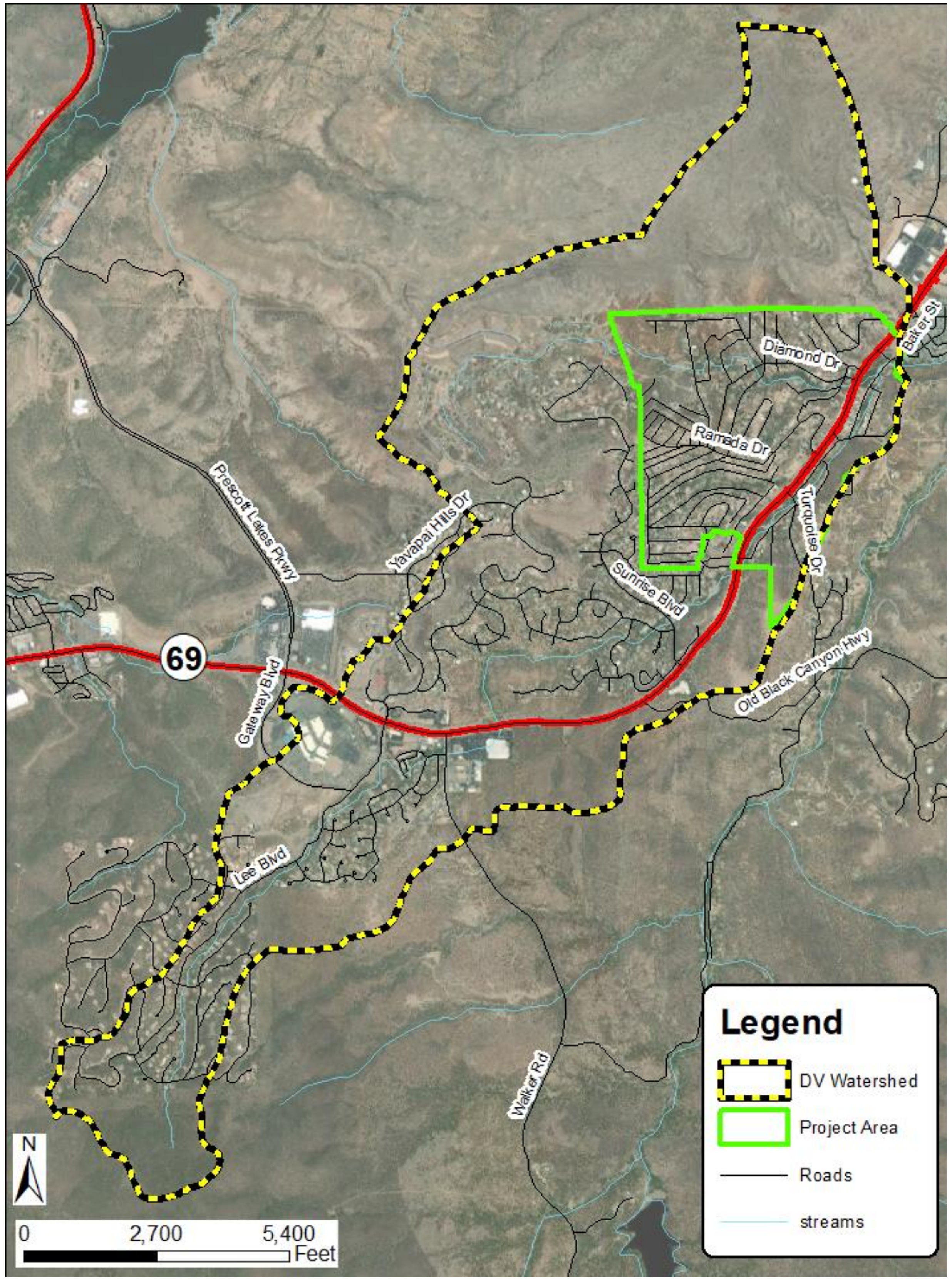


Figure 1.3: Aerial Map

2. Project History

2.1 Previous Master Plan

The Diamond Valley Stormwater Master Plan was previously completed in 1999 by ASL Consulting Engineers (ASL Consulting Engineers, 1999). The plan consisted of drainage improvements to Onyx Dr, Alberson Wash floodplain delineation, drainage alternatives for Alberson Wash along State Route 69, bank protection near Topaz Road and Jade Circle, and proposed culvert crossings for the Diamond Valley subdivision. This study was referenced during the project development.

2.2 FEMA and Floodplain Delineation for Alberson Wash

Alberson Wash is located within the watershed and is defined as Zone AE with floodway. The extents of the FEMA floodplain and floodway are roughly from Baker Street upstream to State Route 69. The floodplain delineation was performed by ASL Consulting Engineers (ASL Consulting Engineers, 1999) with the Diamond Valley Stormwater Master Plan. FEMA Flood Insurance Study Summary of Discharges shows Alberson Wash has discharge rate of 3,010 cfs for the 10-year storm (10% annual-chance) and 4,900 cfs for the 100-year storm (1% annual-chance) at the downstream end of the detailed study as shown in Table 2.1.

Table 2.1: FEMA FIS Summary of Discharge Table

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Agua Fria River (At Black Canyon City)	At the downstream limit of detailed study	1,055	28,500	*	56,700	70,200	124,800
Agua Fria River (At Black Canyon City)	Upstream of confluence with Black Canyon Creek	808	19,300	*	38,900	48,600	86,400
Agua Fria River (At the Town of Dewey-Humboldt)	At downstream limit of detailed study	164	19,300	*	38,900	48,600	86,400
Agua Fria River (At the Town of Dewey-Humboldt)	Upstream of confluence with Clipper Wash	81.0	6,800	*	17,250	23,200	50,200
Agua Fria River (At Town of Prescott Valley)	At downstream limit of detailed study	19.0	2,440	*	6,490	8,250	14,200
Alberson Wash	At downstream limit of detailed study	4.43	3,010	*	4,330	4,900	6,220
Alberson Wash Tributary	At confluence with Alberson Wash	1.53	1,260	*	1,780	2,000	2,490
American Wash	At North American Ranch Road	3.16	1,122	1,660	2,101	2,589	3,920
American Wash	At North Scarlett Drive	2.72	964	1,422	1,800	2,212	3,326

Figure 2.1 shows the effective FEMA floodplain delineations for Alberson Wash and the surrounding area.

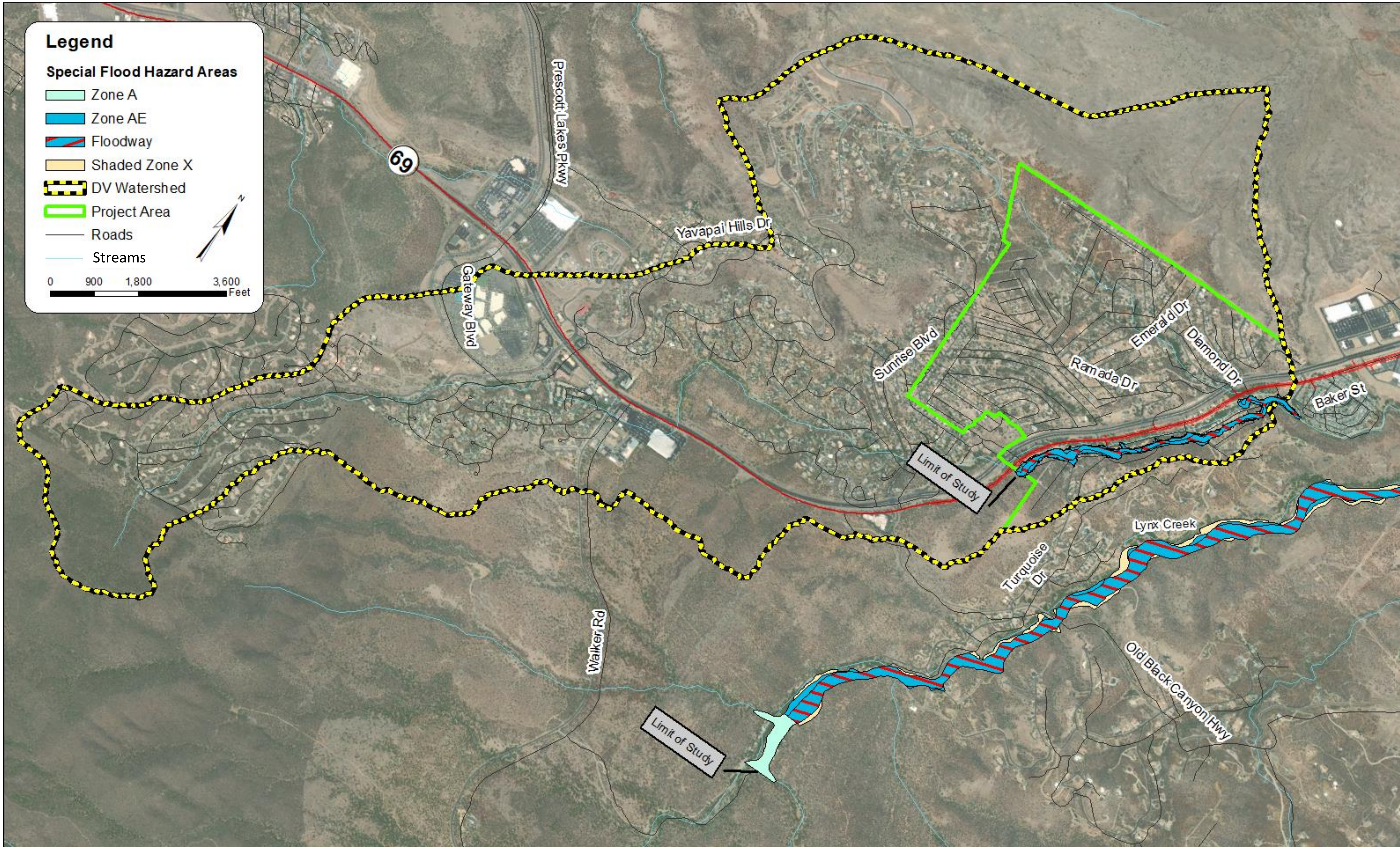


Figure 2.1: FEMA Floodplain in Project Vicinity

3. Diamond Valley Area Drainage Master Plan (ADMP)

3.1 Description

The study and plan defined flood hazards for the Diamond Valley Watershed by using detailed two-dimensional modeling, current hydrologic and hydraulic parameters, and methodologies per the Drainage Design Manual for Yavapai County (DDM) (Yavapai County, 2015). Once flood hazards were determined, mitigation projects were developed to reduce flooding impacts and continue to build resiliency within the watershed. A decision matrix was compiled to select preferred projects and prioritize efforts. Public input was included in the decision matrix as a major component. The preferred projects were developed into 15% plans with an engineer's estimate of probable cost.

3.2 Goals

The overarching goals for the Diamond Valley ADMP are as follows:

- Generate a detailed two-dimensional hydraulic model for the Diamond Valley Watershed.
- Determine flood hazard areas based on two-dimensional model results and public input.
- Based on the flood hazard analysis effort, identify Areas of Mitigation Interest (AOMI's). AOMI's are flood prone areas where a potential solution has been identified.
- Based on a collaborative decision matrix, prioritize the AOMI's.
- For the top 5 AOMI's after prioritization develop conceptual design and cost associated with construction.

4. Survey and Terrain Data

The terrain data were collected from Yavapai County and City of Prescott for the watershed. The data was provided in both CADD and GIS file formats. The terrain was compiled in GIS using contour data to generate a seamless raster surface for the entire watershed that was used for hydrologic and hydraulic analyses. The terrain data was projected using North American Datum of 1983 State Plane Arizona Central in feet for the horizontal coordinate system and North American Vertical Datum of 1988 for the vertical datum. The topographic map can be seen in Figure 4.1.

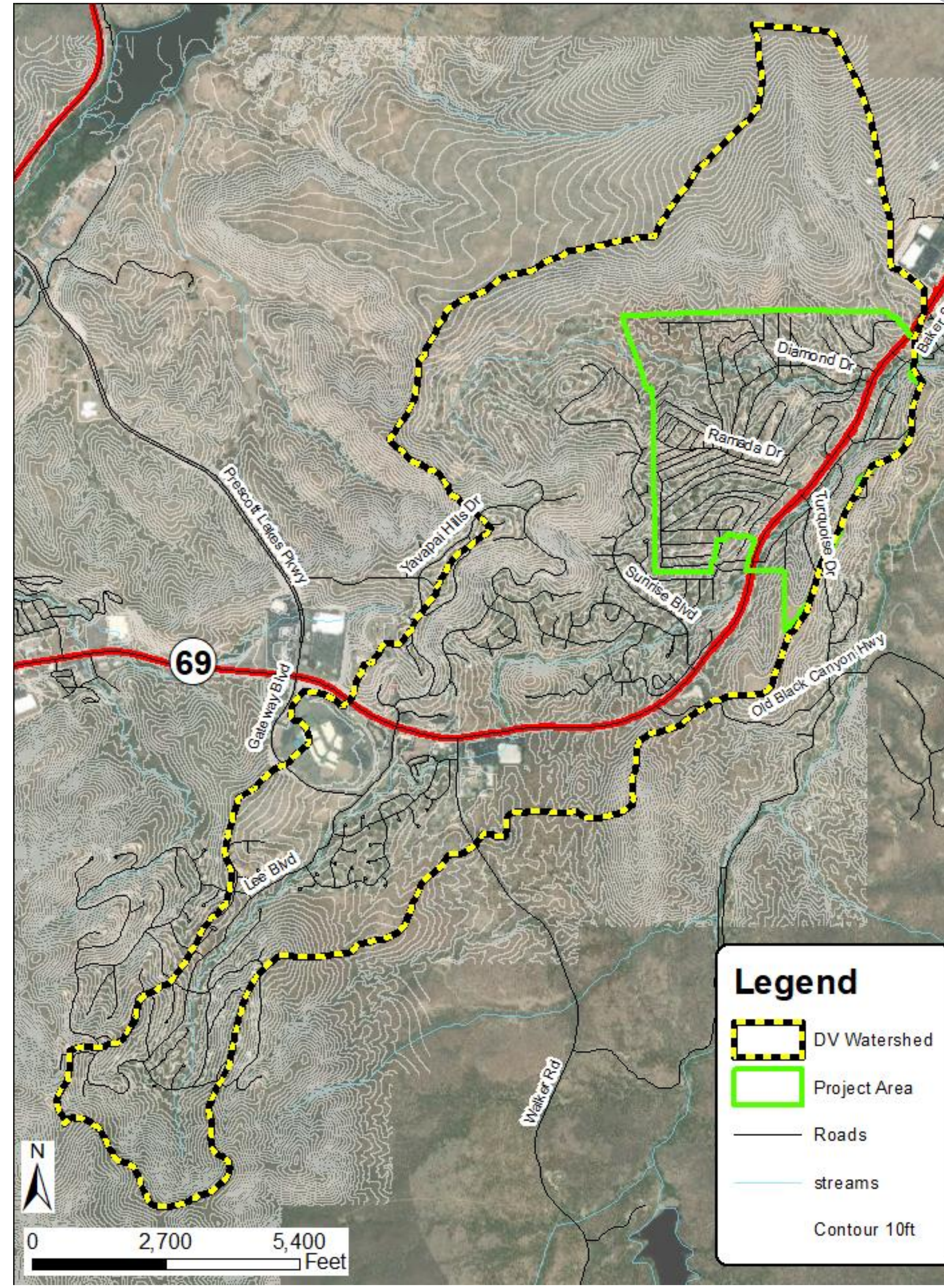


Figure 4.1: Topographic Map

5. Hydrology

5.1 Methodology

The hydrology was developed in stages by first using HEC-HMS Version 4.3 (USACE HEC-HMS) for the Diamond Valley Watershed. Two major sub-basins were delineated, and hydrologic parameters were assigned using the methodologies from the Drainage Design Manual for Yavapai County (Yavapai County, 2015). The time-series rainfall excess generated from the HEC-HMS model was then used in the HEC-RAS (USACE HEC-RAS) Version 5.0.7 two-dimensional model. A FLO-2D model (FLO-2D) Build No 16.06.16 was also created using the hydrologic parameters and including major culverts for flow connectivity. The HEC-HMS, HEC-RAS, and FLO-2D models were compared against each other for model verification of hydrologic conditions. The HEC-RAS model was used for flood hazard identification.

5.2 Sub-basins

Two major sub-basins (DV-1 and DV-2) were delineated using the terrain data for the Diamond Valley Watershed. Both sub-basins contribute to Alberson Wash. These sub-basins can be seen in Figure 5.1.

Figure 5.1: Sub-basin Map

Table 5.1 shows the drainage areas for the Diamond Valley Sub-basins.

Table 5.1: Sub-basin Drainage Areas

Sub-Basin	Drainage Area (sq. mi.)
DV-1	2.86
DV-2	1.93
Outfall	4.79

5.3 Rainfall and Storm Duration

NOAA14 rainfall was used across all models. The HEC-RAS two-dimensional model only has an input of rainfall excess from the HEC-HMS model. HEC-HMS used a frequency storm with values from NOAA14. Table 5.2 shows the rainfall inputs for both the 6-hour and 24-hour storms for the HEC-HMS model.

Table 5.2: NOAA 14 Rainfall Data

Duration	100-year, 6-hour (inches)	100-year, 24-hour (inches)
5 minutes	0.89	0.89
15 minutes	1.67	1.67
1 hour	2.79	2.79
2 hours	3.10	3.10
3 hours	3.15	3.15
6 hours	3.37	3.37
12 hours	-	3.79
1 day	-	4.93

The FLO-2D model used the spatially varied rainfall data from NOAA14 GIS rasters for the 100-year, 6-hour and 100-year, 24-hour storm events. Hypothetical rainfall distributions were developed for both the 6-hour and 24-hour durations from HEC-HMS output of the cumulative rainfall time-series. This approach maintains consistency between the HEC-HMS and FLO-2D model for comparison and verification of results. A graph of the 6- and 24-hour distributions is provided below.

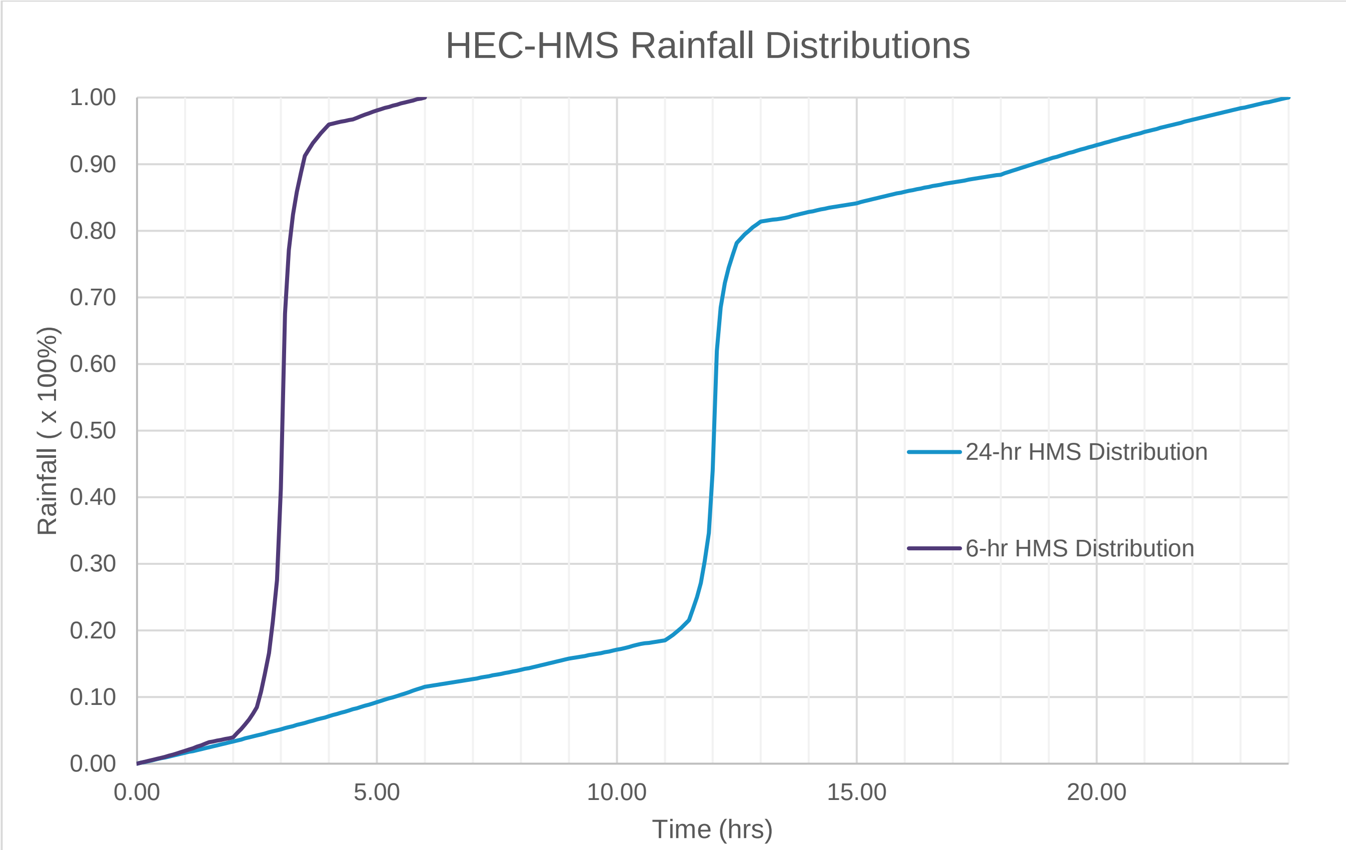


Figure 5.2: Rainfall Distributions

The controlling storm duration was analyzed in HEC-HMS. The 24-hour storm generates higher peak flow and runoff volume for this specific watershed. The 24-hour duration was used for plan development. A summary of the peak flows and runoff volumes for the sub-basins are shown in Table 5.3 and Table 5.4 from the HEC-HMS model.

Table 5.3: Peak Flow Comparisons

Sub-Basin	Drainage Area (sq. mi.)	100-year, 6-hour Peak Flow (cfs)	100-year, 24-hour Peak Flow (cfs)
DV-1	2.86	3,621	3,812
DV-2	1.93	3,388	3,551
Total	4.79	6,865	7,208

Table 5.4: Volume Comparisons

Sub-Basin	Drainage Area (sq. mi.)	100-year, 6-hour Volume (AC-ft)	100-year, 24-hour Volume (AC-ft)
DV-1	2.86	394.3	514.5
DV-2	1.93	268.9	324.9
Total	4.79	663.2	839.4

In addition to the 100-year, the 2- and 10-year storms were modeled in HEC-HMS and HEC-RAS for the 24-hour duration.

5.4 Unit Hydrograph

The Clark Unit Hydrograph was used for the HEC-HMS model for Sub-basins DV-1 and DV-2 per the DDM. The time of concentration was calculated using the urban classification as shown in Equation 7.17 of the DDM. The watershed was classified as urban for this analysis since most of the watercourse is located in subdivisions, commercial centers or adjacent to development.

urban

$$T_c = 3.2A^{0.1}L^{0.25}{L_{ca}}^{0.25}S^{-0.14}RTIMP^{-0.36} \qquad 7.17$$

where:

Tc	=	time of concentration, in hours,
A	=	area, in square miles,
S	=	watercourse slope, in feet/mile,
L	=	length of watercourse to the hydraulically most distant point, in miles,
Lca	=	length measured from the concentration point along L to a point on L that is perpendicular to the watershed centroid, in miles, and
RTIMP	=	effective impervious area, in percent.

$$R = 0.37{T_c}^{1.11}L^{0.80}A^{-0.57} \qquad 7.18$$

where: R is in hours and the variables are as defined for the T_c equations.

Figure 5.3: Time of Concentration (Tc) and Storage Coefficient (R) Equations (Yavapai County, 2015)

Table 5.5 shows the time of concentration and storage values with the associated variables for each Sub-basin (DV-1 and DV-2).

Table 5.5: Time of Concentration (Tc) and Storage Coefficient (R)

Sub-Basin	Upstream Elev (ft)	Downstream Elev (ft)	Length (mi)	Area (sq. mi)	Lca (mi)	Slope (ft/mi)	Tc (hrs) Urban	R (hrs)
DV-1	6,425	5,195	5.25	2.86	2.67	234.14	0.84	0.63
DV-2	5,584	5,210	2.66	1.93	1.00	140.43	0.70	0.38

5.5 Landuse

A landuse shapefile was generated as part of the project with hydrologic and hydraulic parameters initial abstraction (IA), effective impervious areas (RTIMP), n-values, and vegetation cover. The HEC-HMS model uses IA, RTIMP, and vegetation cover to calculate rainfall losses. FLO-2D uses IA, RTIMP, and n-values for these calculations. N-values were initially assigned and then adjusted in the HEC-RAS model to calibrate results. The spatially varied landuse is shown in Figure 5.4. Table 5.6 shows a summary of the landuse parameters for this study.

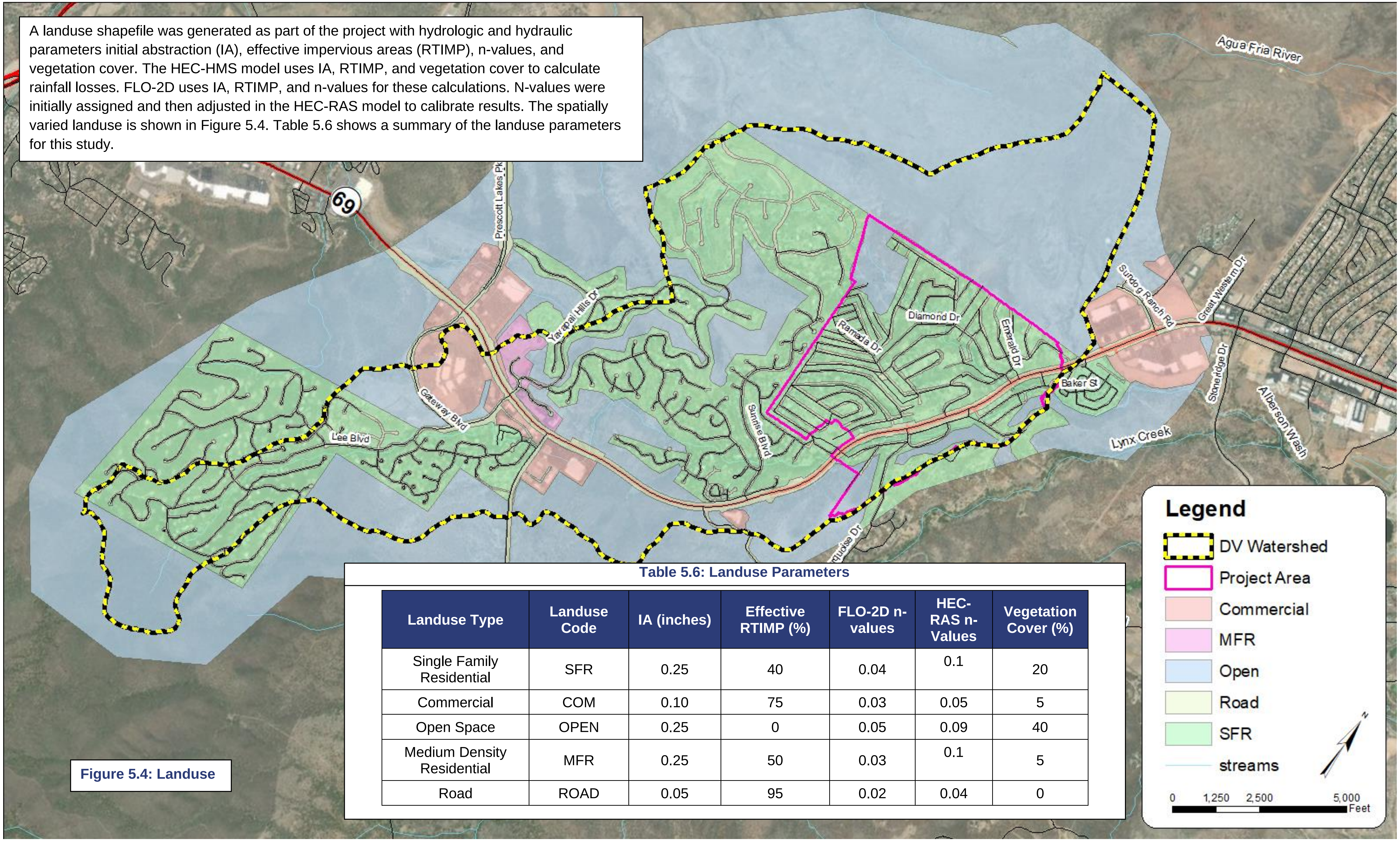


Figure 5.4: Landuse

Table 5.6: Landuse Parameters

Landuse Type	Landuse Code	IA (inches)	Effective RTIMP (%)	FLO-2D n-values	HEC-RAS n-Values	Vegetation Cover (%)
Single Family Residential	SFR	0.25	40	0.04	0.1	20
Commercial	COM	0.10	75	0.03	0.05	5
Open Space	OPEN	0.25	0	0.05	0.09	40
Medium Density Residential	MFR	0.25	50	0.03	0.1	5
Road	ROAD	0.05	95	0.02	0.04	0

5.6 Soils

Soils data were collected from Arizona Department of Transportation (ADOT) with Green-Ampt parameters that include the hydraulic conductivity (XKSAT), wilting point (WPOINT), field capacity (FCAPAC), saturation (SAT), percent rock (PERC ROCK), wetting front capillary suction (PSIF), volumetric soil moisture deficit for dry (DTHETA Dry) and normal (DETHETA normal) conditions. DETHETA normal is calculated by subtracting the saturated condition from the field capacity. DTHETA dry is calculated by subtracting the saturated condition from the wilting point. The spatially varied soil data can be seen in Figure 5.5. Table 5.7 is a summary of the hydrologic parameters used.

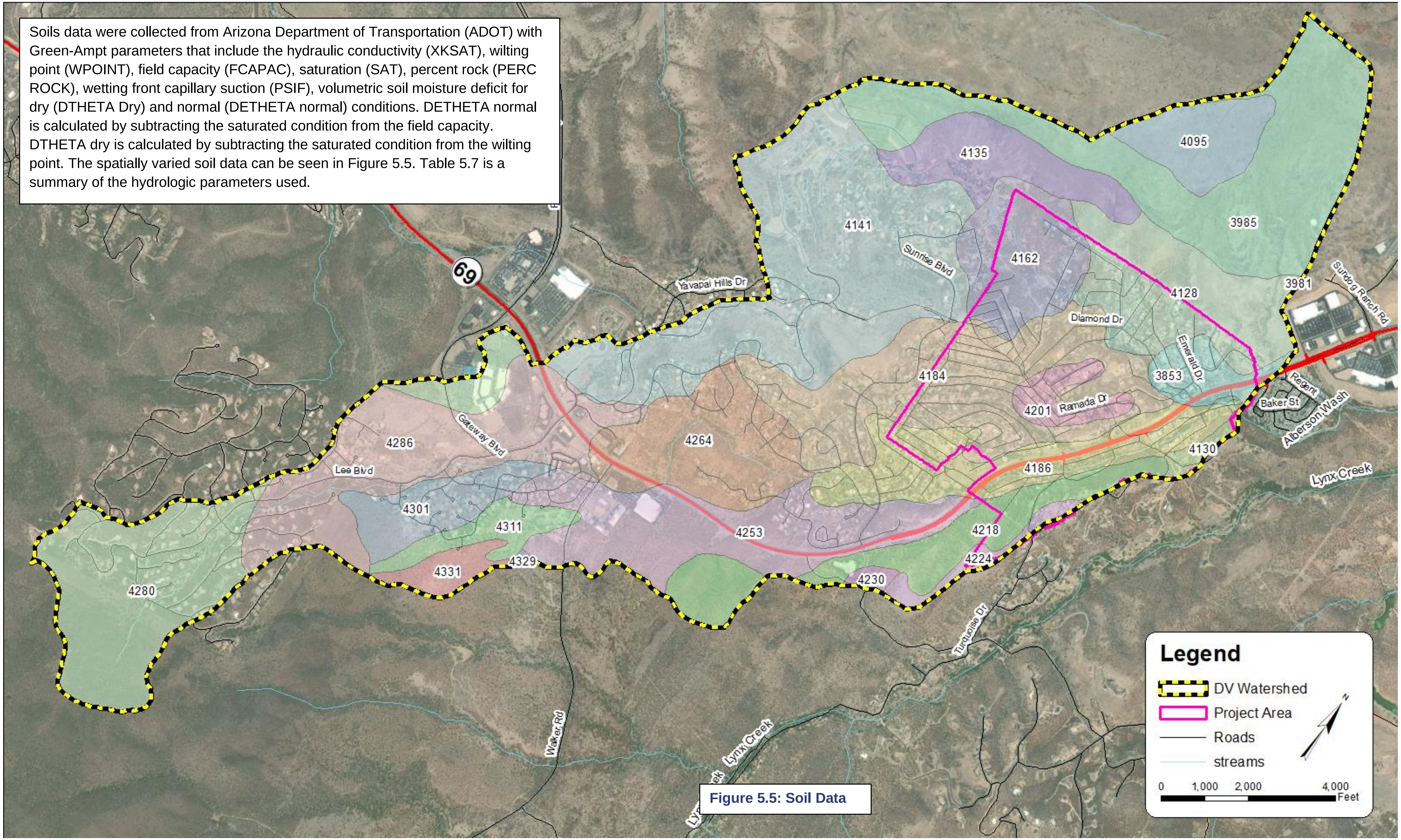


Figure 5.5: Soil Data

Table 5.7: Soil Parameters

MUKEY	Soil Name	MUSYM	WPOINT	FCAPAC	SAT	DTHETA Dry	DTHETA Normal	PSIF (inches)	XKSAT (in/hr)	PERC ROCK (%)
52875	Lonti complex, 2-30% slopes	LoD	0.1	0.21	0.43	0.22	0.33	5.32	0.44	0
52817	Arp very rocky clay loam, 20-40% slopes	AwE	0.27	0.4	0.48	0.08	0.21	15.81	0.02	20
52872	Lonti gravelly loam, 0-8%slopes	LmB	0.13	0.26	0.43	0.17	0.3	11.62	0.2	0
52818	Arp-Moano complex, 0-30% slopes	AxD	0.21	0.35	0.46	0.11	0.25	14.57	0.05	0
52816	Arp cobbly clay loam, 10-25% slopes	AvD	0.27	0.4	0.48	0.08	0.21	15.81	0.02	0
52892	Moano very rocky loam, 15-60% slopes	MkF	0.13	0.26	0.43	0.17	0.3	12.81	0.18	20
52824	Barkerville cobbly sandy loam, 20-60% slopes	BmF	0.08	0.17	0.42	0.25	0.34	3.32	0.63	0
52891	Moano gravelly loam, 0-30% slopes	MgD	0.13	0.26	0.43	0.17	0.3	12.81	0.18	0
52825	Barkerville very stony sandy loam, 5-25% slopes	BnD	0.1	0.2	0.42	0.22	0.32	5.91	0.28	0
52931	Thunderbird cobbly clay loam, 0-15% slopes	TdC	0.27	0.4	0.48	0.08	0.21	15.73	0.02	0
52883	Lynx soils	Ly	0.16	0.3	0.44	0.14	0.28	13.77	0.15	0
52873	Lonti cobbly loam, 0-15% slopes	LnC	0.14	0.28	0.43	0.15	0.29	13.64	0.16	0
52925	Springerville-Cabezon complex, 3-30% slopes	SnD	0.29	0.41	0.49	0.08	0.2	13.6	0.02	0
52831	Cabezon-Springerville complex, 5-25 % slopes	CaD	0.28	0.41	0.49	0.08	0.21	14.03	0.02	0
52932	Thunderbird cobbly clay loam, 15-40% slopes	TdE	0.27	0.4	0.48	0.08	0.21	15.73	0.02	0

The XKSAT for HEC-HMS was adjusted based on the Vegetation Cover in the landuse file by using Equation 7.10 in the DDM. The limiting infiltration depth for the FLO-2D model was assigned based on results calculated from the HEC-HMS model. HEC-HMS computes the infiltration depth per timestep for both Sub-basins DV-1 and DV-2. The average infiltration depths for both sub-basins were then used to assign the infiltration depth in FLO-2D. Figure 5.6 show the time-series infiltration depths from HEC-HMS for both the 6- and 24-hour duration.

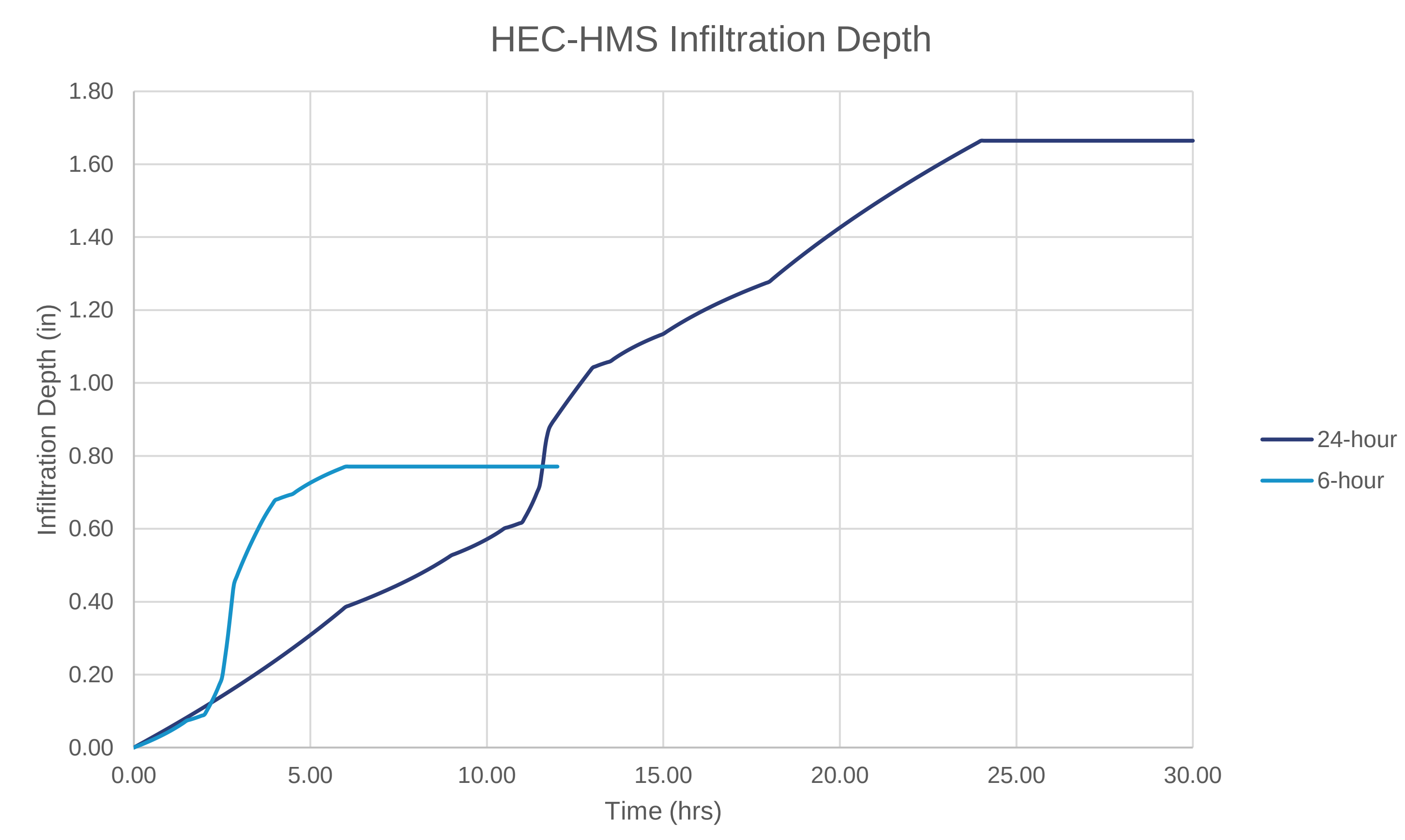


Figure 5.6: HEC-HMS Infiltration Depths

The infiltration depth from HEC-HMS was then divided by the DTHETA from the soil data to define the limiting soil depth in FLO-2D to account for the porosity of the soil. Table 5.8 summarizes the Limiting Soil Infiltration Depth assigned in FLO-2D.

Table 5.8: Limiting Soil Infiltration Depth

Duration	Average Infiltration Depth (in)	DTHETA Range	Limiting Soil Infiltration Depth (ft)
24-hour	1.6	0.20 – 0.34	0.41 - 0.69

5.7 HEC-HMS Rainfall Loss Summary

The landuse and soil GIS data were analyzed based on the delineated sub-basins and weighted based on coverage for each sub-basin. The initial abstraction (IA or Max Storage), the soil moisture content (FCAPAC and SAT), vegetation cover percentage, and the impervious percentage (RTIMP) use the simple area-weighted procedure as outlined in the DDM. The hydraulic conductivity (XKSAT) and soil suction (PSIF) were computed using the log-averaging method per the DDM. The RTIMP and rock percentage were added together for the final RTIMP that was used in the HEC-HMS model. Table 5.9 is a summary of the HEC-HMS input values for both sub-basins.

Table 5.9: HEC-HMS Input Summary

Sub-basin	IA (in)	Vegetation Cover (%)	RTIMP (%)	ROCK (%)	Final RTIMP (%)	XKSAT Bare Ground (in/hr)	XKSAT Adj (in/hr)	PSIF (in)	FCAPAC	SAT
DV-1	0.21	22.89	36.39	4.64	41.04	0.11	0.12	12.32	0.29	0.44
DV-2	0.23	28.91	23.39	0.00	23.39	0.04	0.05	13.21	0.36	0.47

5.8 Rainfall Excess

The rainfall excess for the 2-, 10-, and 100-year storms from HEC-HMS Sub-basin DV-2 was input into the HEC-RAS two-dimensional model. Sub-basin DV-2 had a slightly higher rainfall excess (+0.01 in) at the peak of the storm in the HEC-RAS model. After a few iterations of n-values adjustments, the HEC-RAS two-dimensional model was producing similar results to that of HEC-HMS and FLO-2D. The n-value adjustments are discussed in Section 6.4.

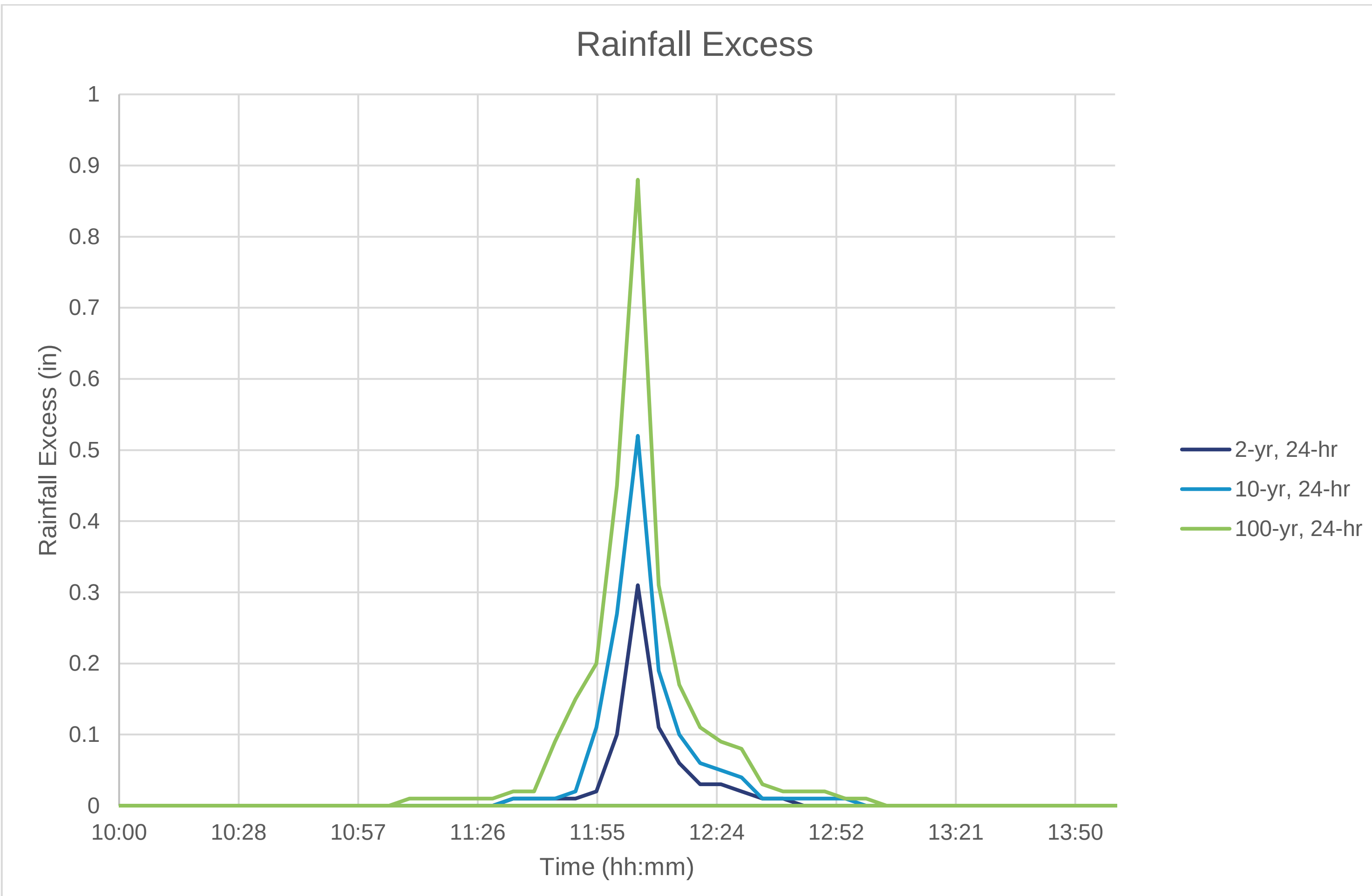


Figure 5.7: Rainfall Excess

Table 5.10 summarizes the cumulative rainfall, rainfall losses, and the excess rainfall for the 2-, 10-, and 100-year, 24-hour storms for DV-2.

Table 5.10: Rainfall Excess for Sub-basin DV-2 Summary

Return Period	Total Rainfall (in)	Rainfall Loss (in)	Rainfall Excess (in)
2-year, 24-hour	2.26	1.25	1.01
10-year, 24-hour	3.29	1.49	1.80
100-year, 24-hour	4.93	1.78	3.15

5.9 Verification and Comparison

No stream gages are located in the Diamond Valley Watershed. Verification and comparison of the HEC-RAS model results were performed by adjusting the Manning's n-values to better match the peak flow, runoff volume and timing of the peak flow to HEC-HMS and FLO-2D. The n-value adjustments in comparison to what was used in FLO-2D can be found in Table 6.2.

The hydrology comparison of peak flows, runoff volume, and peak flow timing for all three models are summarized in Table 5.11, Table 5.12, and Table 5.13. Two HEC-HMS sub-basins were delineated (DV-1 and DV-2) that contribute to the Outfall. DV-1 and Outfall (combination of DV-1 and DV-2) were compared between all models, while DV-2 is difficult to compare due the split flow conditions as DV-2 combines with DV-1. These locations were scrutinized to provide accurate depictions across all three models (Figure 5.8). FLO-2D used floodplain cross-section (FPXSECs) and HEC-RAS used profile lines at these locations for reporting the peak flow rates, runoff volumes and timing of peak flow.

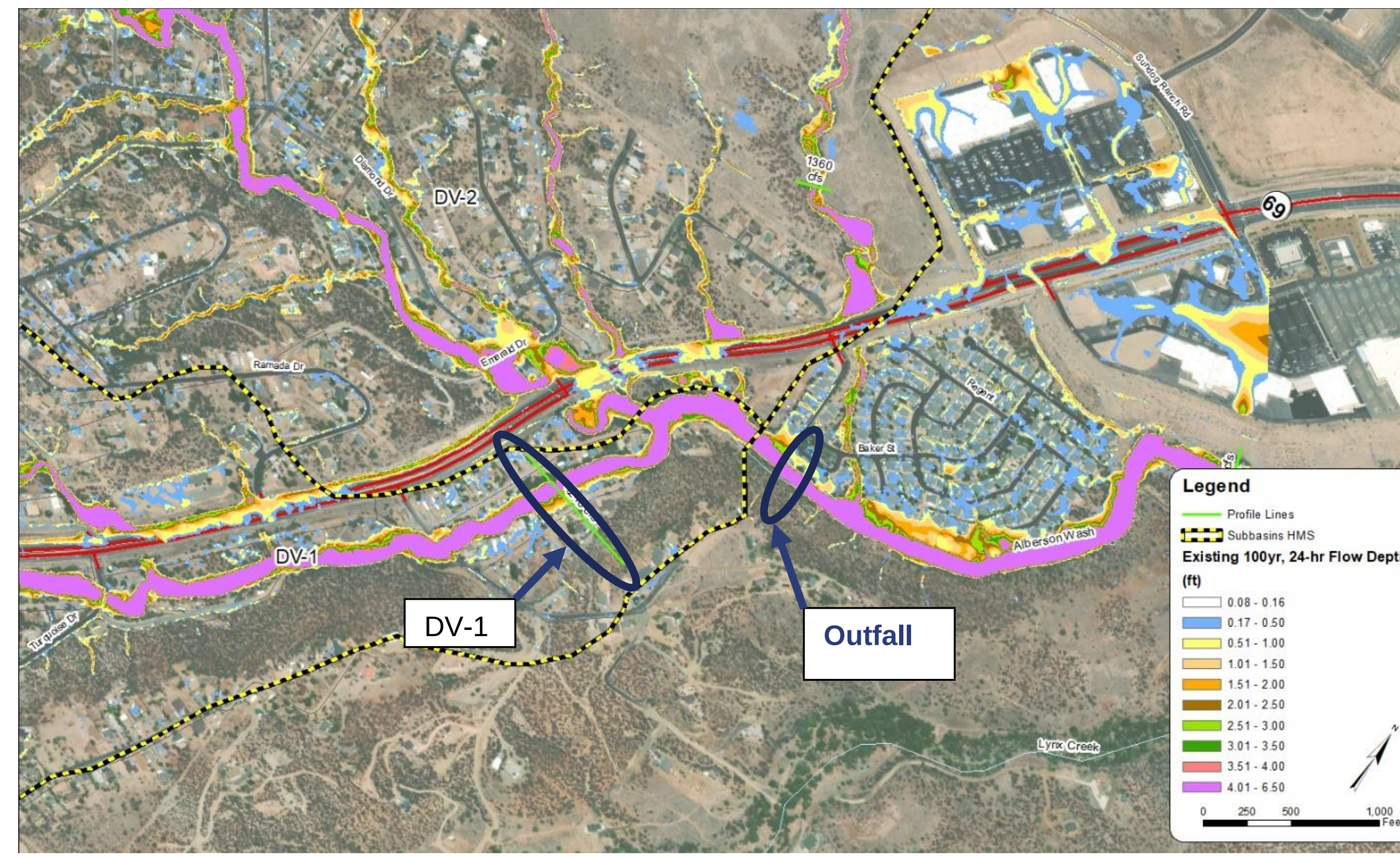


Figure 5.8: Comparison Locations

Table 5.11: 100-year, 24-hour Peak Flow Comparisons

Sub-Basin	Drainage Area (sq. mi.)	HEC-HMS (cfs)	FLO-2D (cfs)	HEC-RAS (cfs)
DV-1	2.86	3,812	4,366	4,248
DV-2	1.93	3,551	-	-
Outfall	4.79	7,208	8,730	7,582

Table 5.12: 100-year, 24-hour Volume Comparisons

Sub-Basin	Drainage Area (sq. mi.)	HEC-HMS (AC-ft)	FLO-2D (AC-ft)	HEC-RAS (AC-ft)
DV-1	2.86	514.5	480.4	392.30
DV-2	1.93	324.9	-	-
Outfall	4.79	839.4	764.9	642.24

Table 5.13: 100-year, 24-hour Timing of the Peak Flow Comparison

Sub-Basin	Drainage Area (sq. mi.)	HEC-HMS (hh:mm)	FLO-2D (hh:mm)	HEC-RAS (hh:mm)
DV-1	2.86	12:45	12:23	12:30
DV-2	1.93	12:35	-	-
Outfall	4.79	12:40	12:23	12:27

The FLO-2D model compared well with the HEC-HMS model with no modifications to the hydrologic parameters. The HEC-RAS model was adjusted based on initial runs using the same Manning's n-values as FLO-2D. The HEC-RAS peak flow was reaching the downstream end of the model considerably faster than the FLO-2D and HEC-HMS models. The n-values in HEC-RAS were incrementally adjusted and increased from what was used in FLO-2D due to the shallow n-value routine and Manning's n-values adjustments that FLO-2D uses for shallow overland flow. These n-value adjustments in HEC-RAS were the only variables adjusted for model refinement. The n-values used for HEC-RAS are compared in Section 6.4.

5.10 Results

With the n-values adjustments, the HEC-RAS model produced comparable results with the HEC-HMS and FLO-2D models. The 2-, 10- and 100-year return periods with the 24-hour controlling duration were used for the remainder of the study. Table 5.14 is a summary of the discharges for the HEC-RAS model. The results can be seen spatially in Section 6.7.

Table 5.14: Summary of Discharge Results

Location	2-year, 24-hour Flow (cfs)	10-year, 24-hour Flow (cfs)	100-year, 24-hour Flow (cfs)
DV-1	835	2,028	4,248
Outfall	1,439	3,450	7,582

6. Hydraulics

6.1 Methodology

The HEC-RAS two-dimensional model was ultimately used for the hydraulic modeling and flood prone area determinations. The HEC-RAS model was composed of a two-dimensional mesh with rainfall excess applied directly to the mesh. The culverts were modeled within the mesh as connections. Culvert sizes and conditions were assessed in the field.

6.2 Model Controls

The model simulation time for the 24-hour storm duration was set to 30 hours. The HEC-RAS computation interval was set to 1 second, while the mapping, hydrograph and detailed output intervals are 3 minutes each.

6.3 Mesh Size and Breaklines

For the HEC-RAS model, an overall 20' x 20' mesh was generated for the model domain which was further refined with breaklines along the major wash conveyances to capture the wash bottoms. The mesh boundary was set to match the sub-basins delineated for the HEC-HMS model. The FLO-2D model also used a grid size of 20' x 20'. The following table shows the summary of the HEC-RAS mesh.

Table 6.1: HEC-RAS Mesh

Number of Cells	384,194
Grid Dimensions	20' x 20'
Max Cell Size	986 sq. ft.
Average Cell Size	396.sq. ft.
Minimum Cell Size	59. sq. ft.

6.4 Manning's n-Values

Manning's n-values were derived from the landuse file utilized for determining the HEC-HMS and FLO-2D infiltration parameters. The n-values were assigned based on generalized roughness of the landuse. The values were assigned per the Flood Control District of Maricopa County FLO-2D Verification Report (FCDMC, 2016). After initial HEC-RAS computations and comparisons with HEC-HMS and FLO-2D, the HEC-RAS model results were showing a consist pattern of the peak flow passing through the watershed faster than the HEC-HMS and FLO-2D models. This happens because HEC-RAS does not have a shallow n variable, nor does it adjust the n-values due to flow depth during the simulation as FLO-2D does. Adjustments to the Manning's n-values were made to slow the flood wave progression downstream in HEC-RAS. Iterations were performed using different n-value adjustments to increase roughness to slow the flood wave progression until the timing and peak flows were comparable to HEC-HMS and FLO-2D. Table 6.2 shows the final n-value comparison between FLO-2D and HEC-RAS.

Table 6.2: Manning's n-Values

Landuse Type	Landuse Code	FLO-2D n-values	HEC-RAS n-Values
Single Family Residential	SFR	0.035	0.10
Commercial	COM	0.03	0.05
Open Space	OPEN	0.05	0.09
Medium Density Residential	MFR	0.03	0.10
Road	ROAD	0.02	0.04

6.5 Culverts and Hydraulic Structures

Field work was conducted to obtain culvert sizes, number of barrels, type and condition. The culverts were then modeled in HEC-RAS using 2D connections. As-builts were also collected from the ADOT database for culverts along the highways. The inlet and outlet inverts were set based as-builts, terrain and existing field observations. The culverts in FLO-2D were modeled using the general culvert equations.

6.6 Boundary Conditions

Downstream boundary conditions were placed along the major conveyances and areas where water was ponding along the boundary of the model. Normal depth boundary conditions were used to remove runoff from the mesh in HEC-RAS. Outflow nodes were place along the boundary of the FLO-2D model.

6.7 Results

The HEC-RAS two-dimensional model results can be seen in the following sheets for the 2-, 10- and 100-year maximum flow depths and velocities.

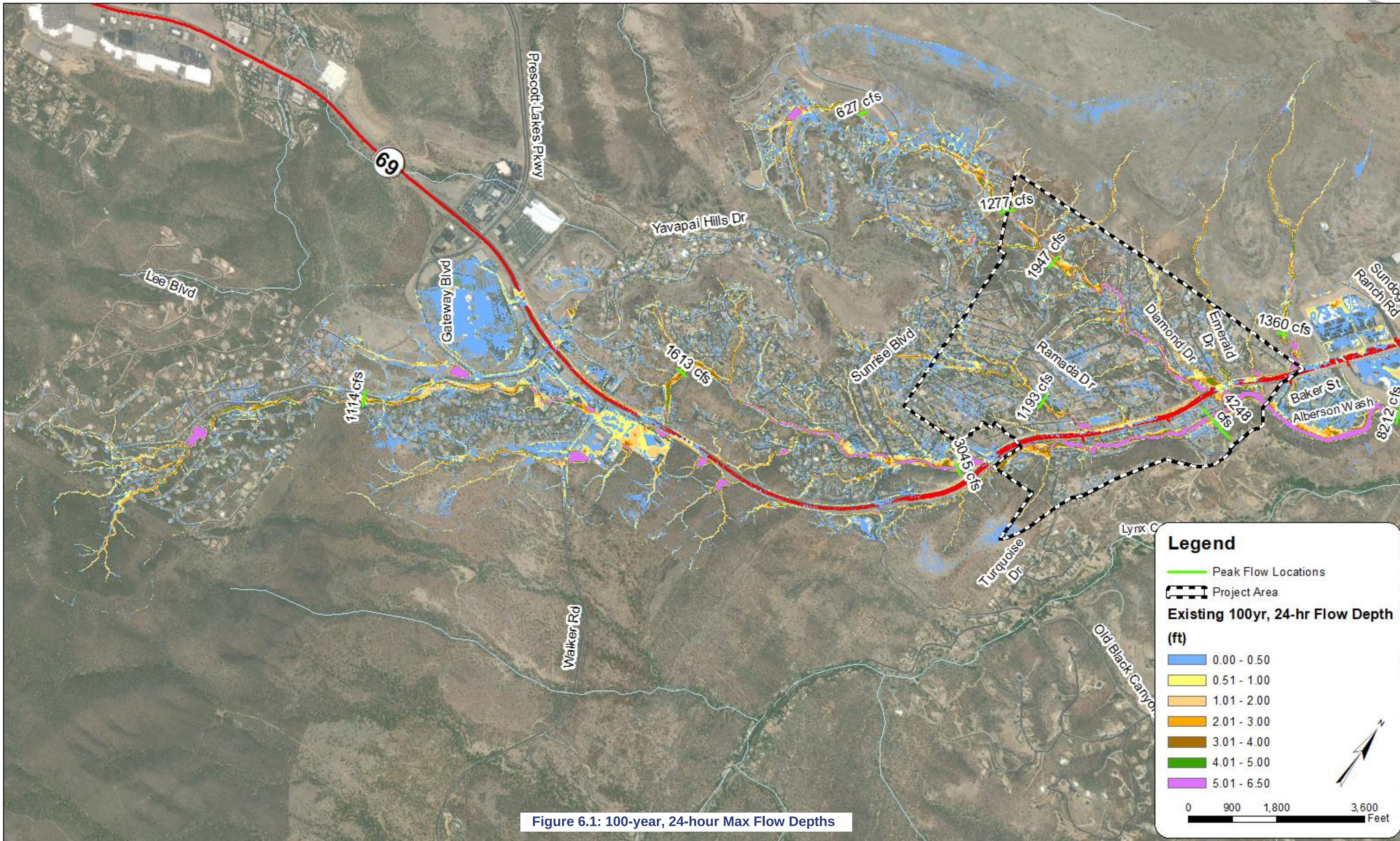


Figure 6.1: 100-year, 24-hour Max Flow Depths

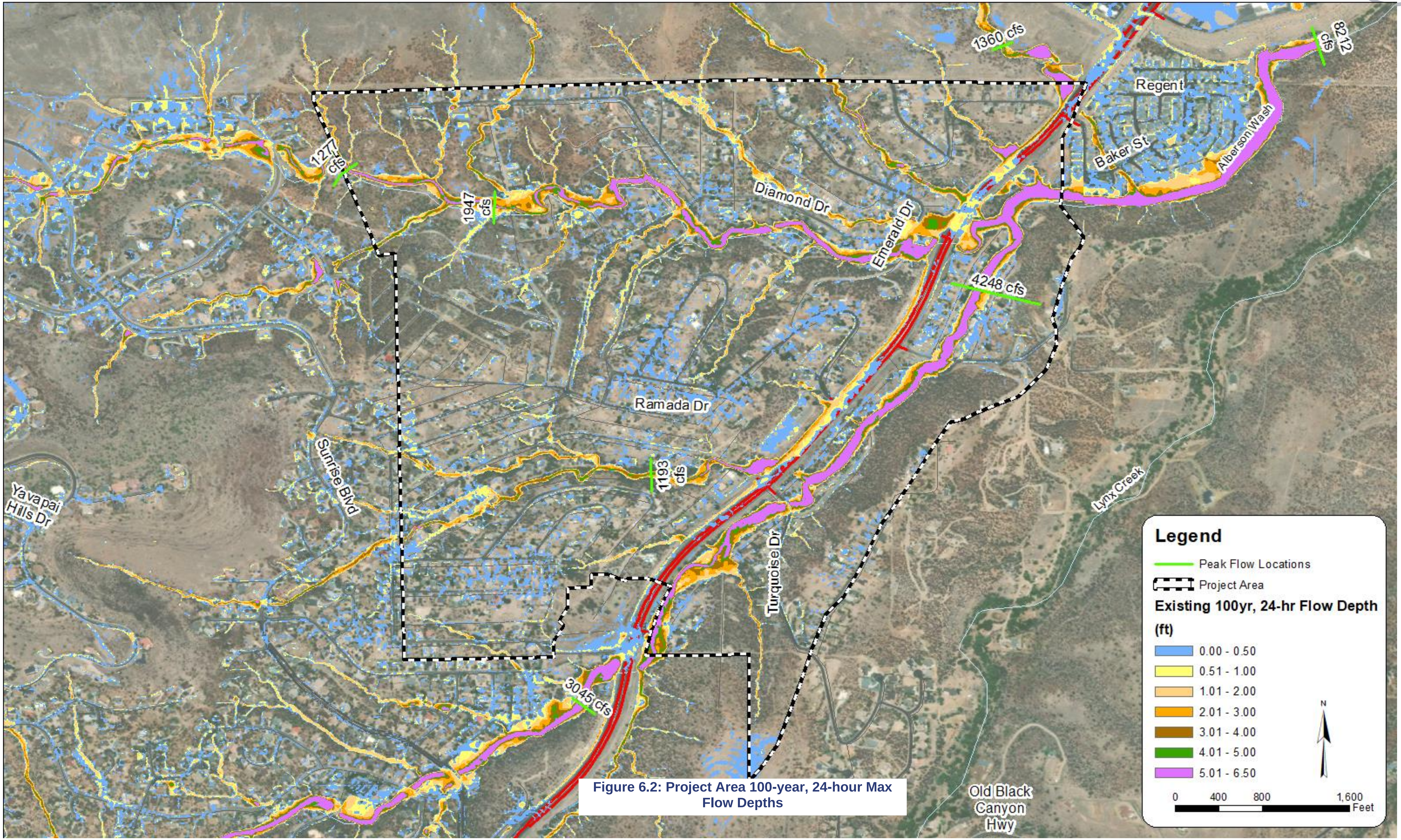


Figure 6.2: Project Area 100-year, 24-hour Max Flow Depths

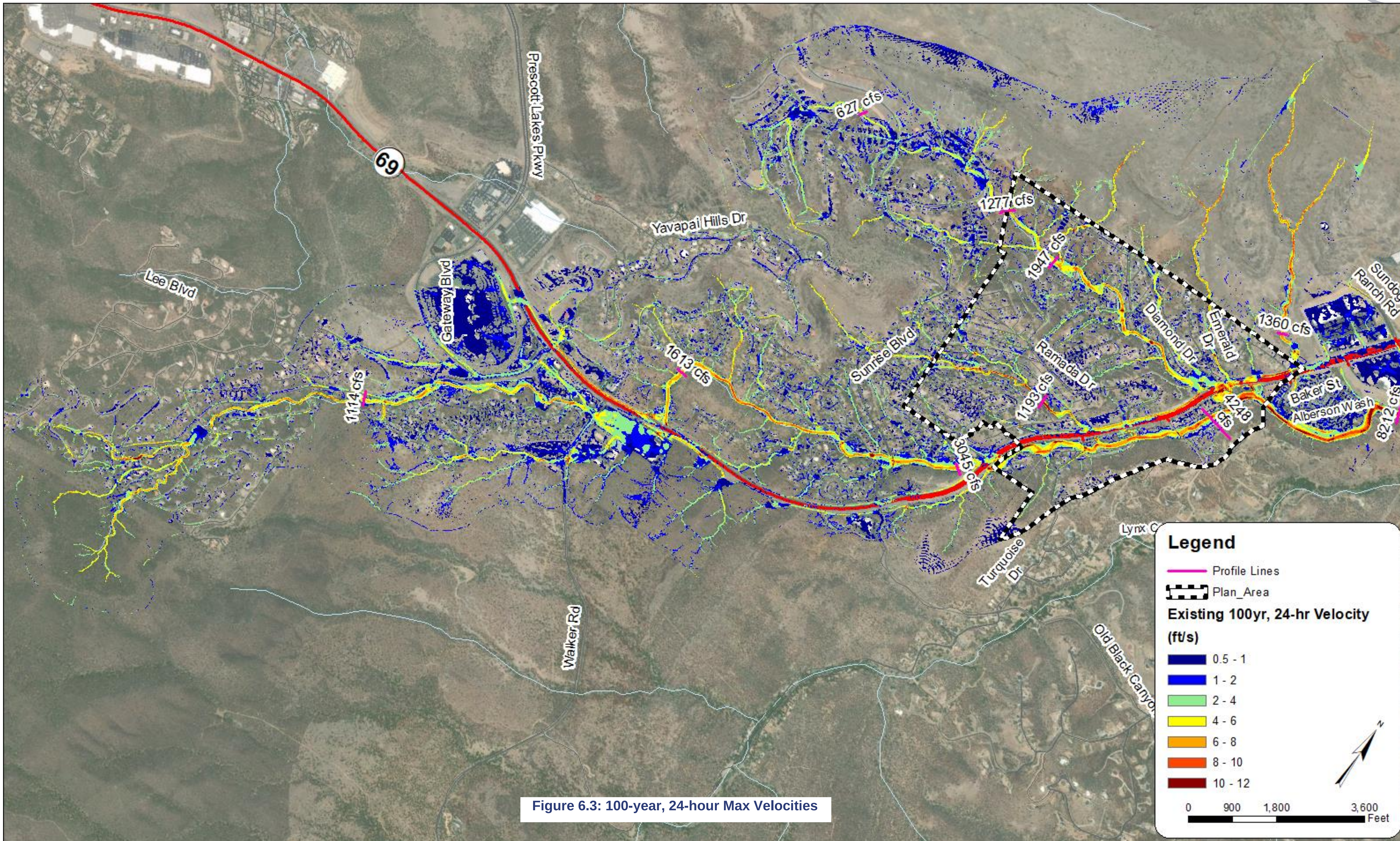


Figure 6.3: 100-year, 24-hour Max Velocities

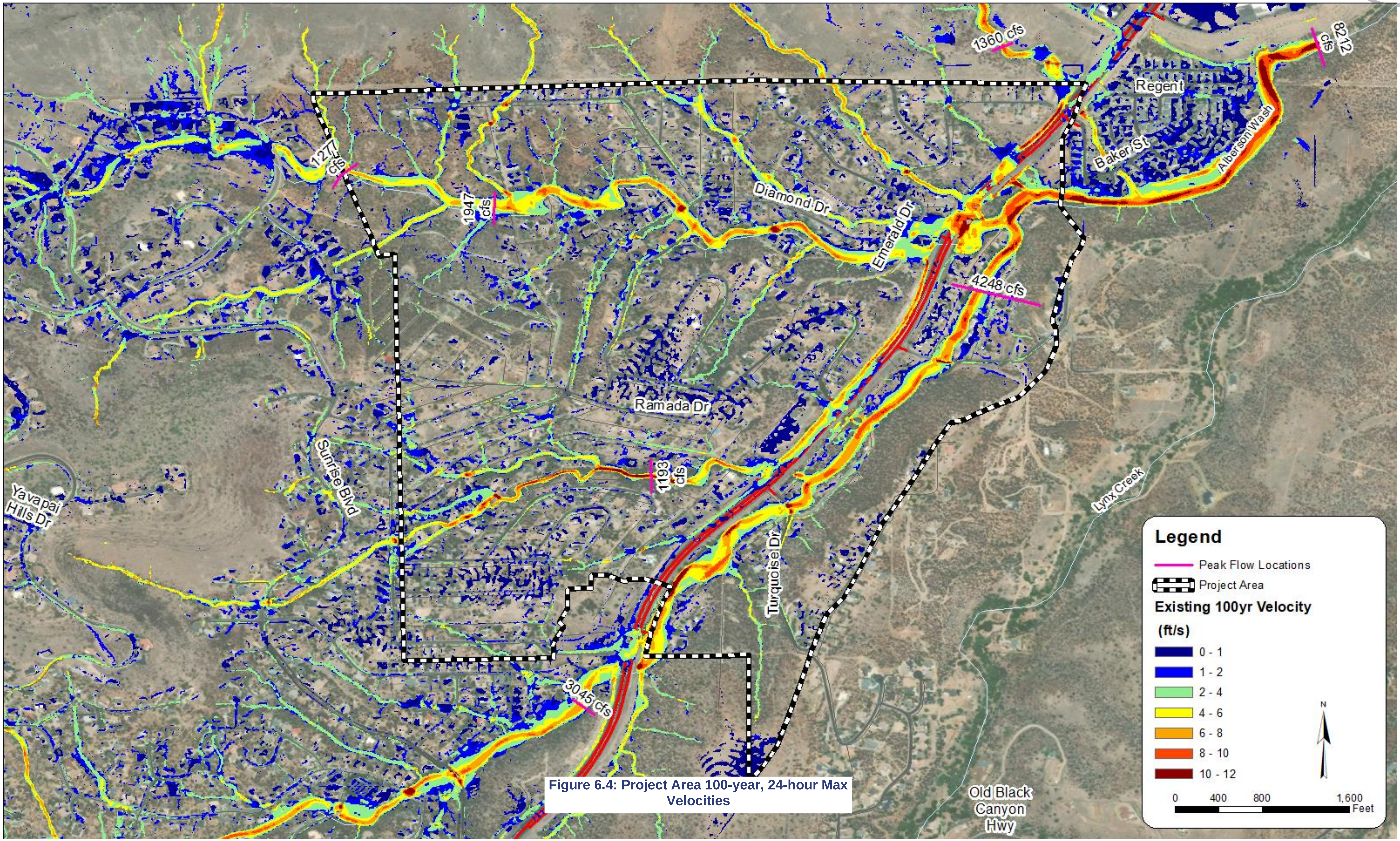


Figure 6.4: Project Area 100-year, 24-hour Max Velocities

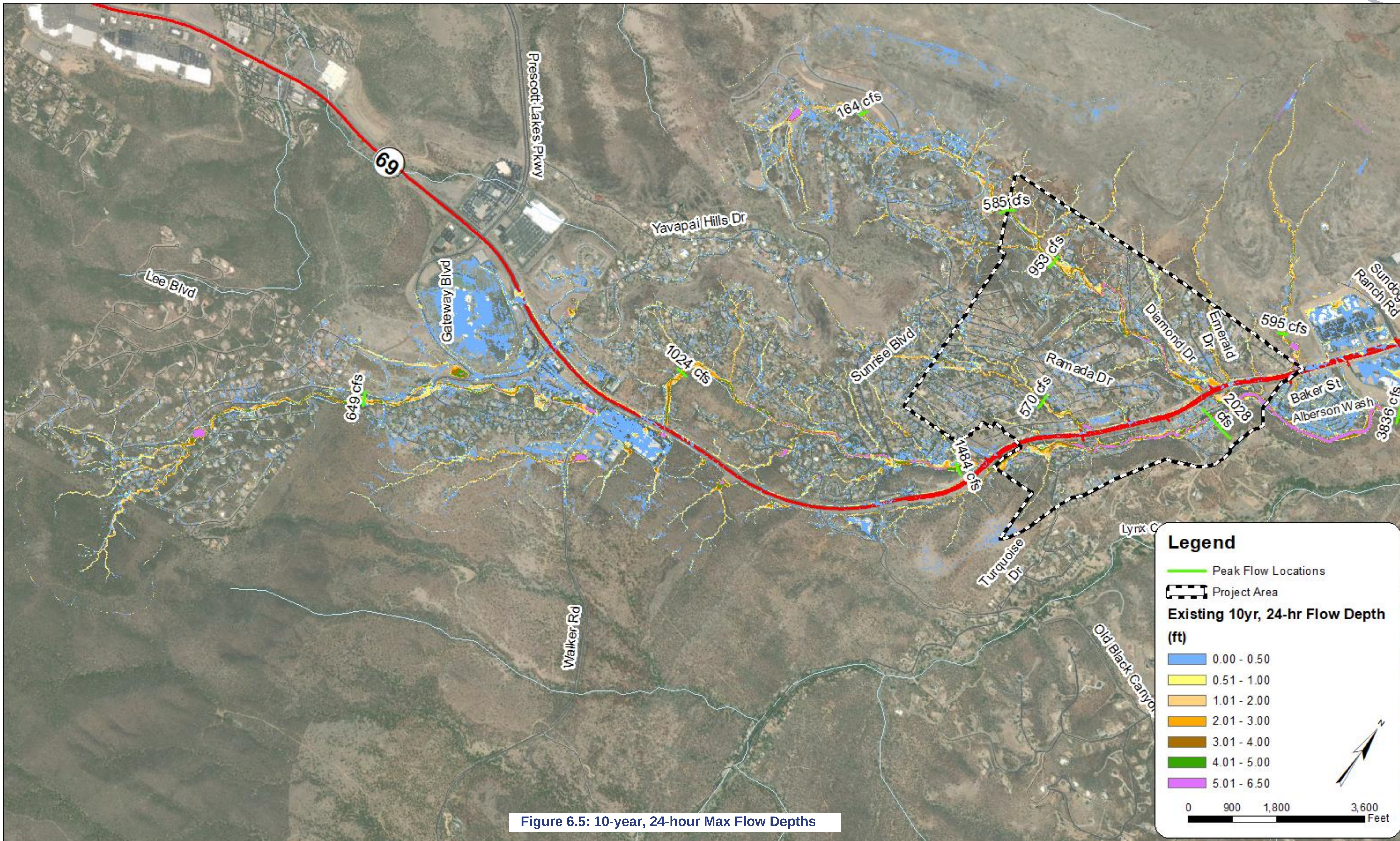


Figure 6.5: 10-year, 24-hour Max Flow Depths

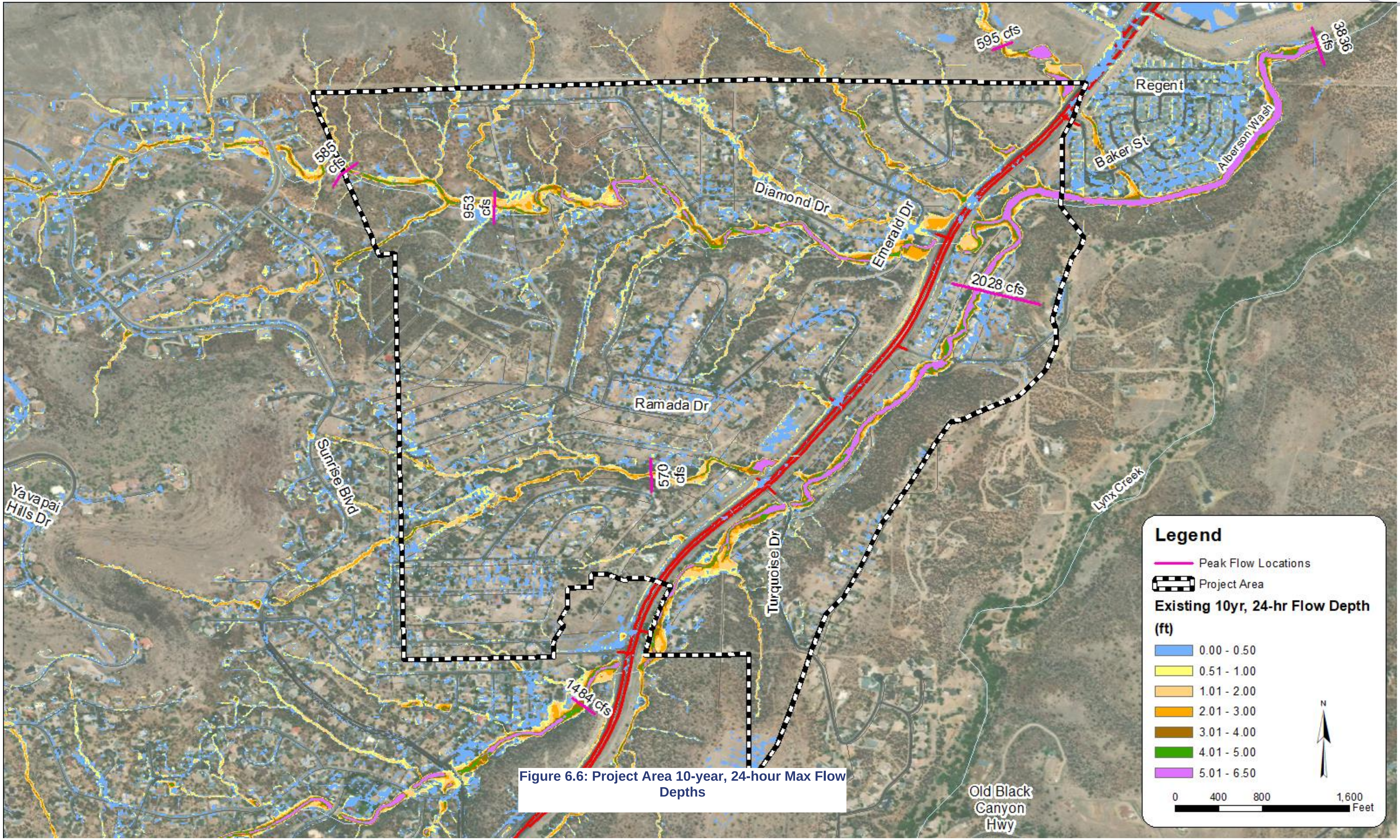


Figure 6.6: Project Area 10-year, 24-hour Max Flow Depths

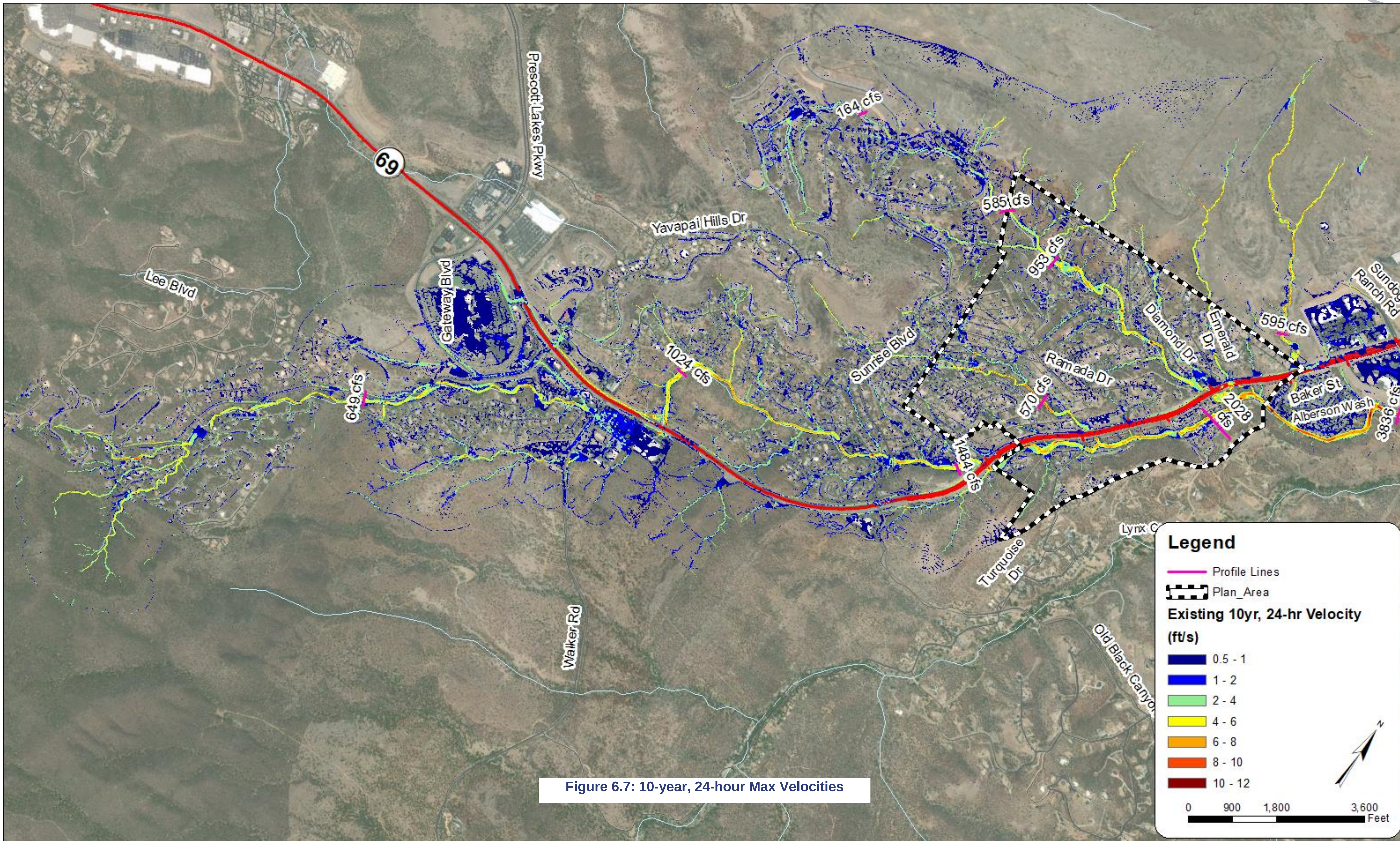


Figure 6.7: 10-year, 24-hour Max Velocities

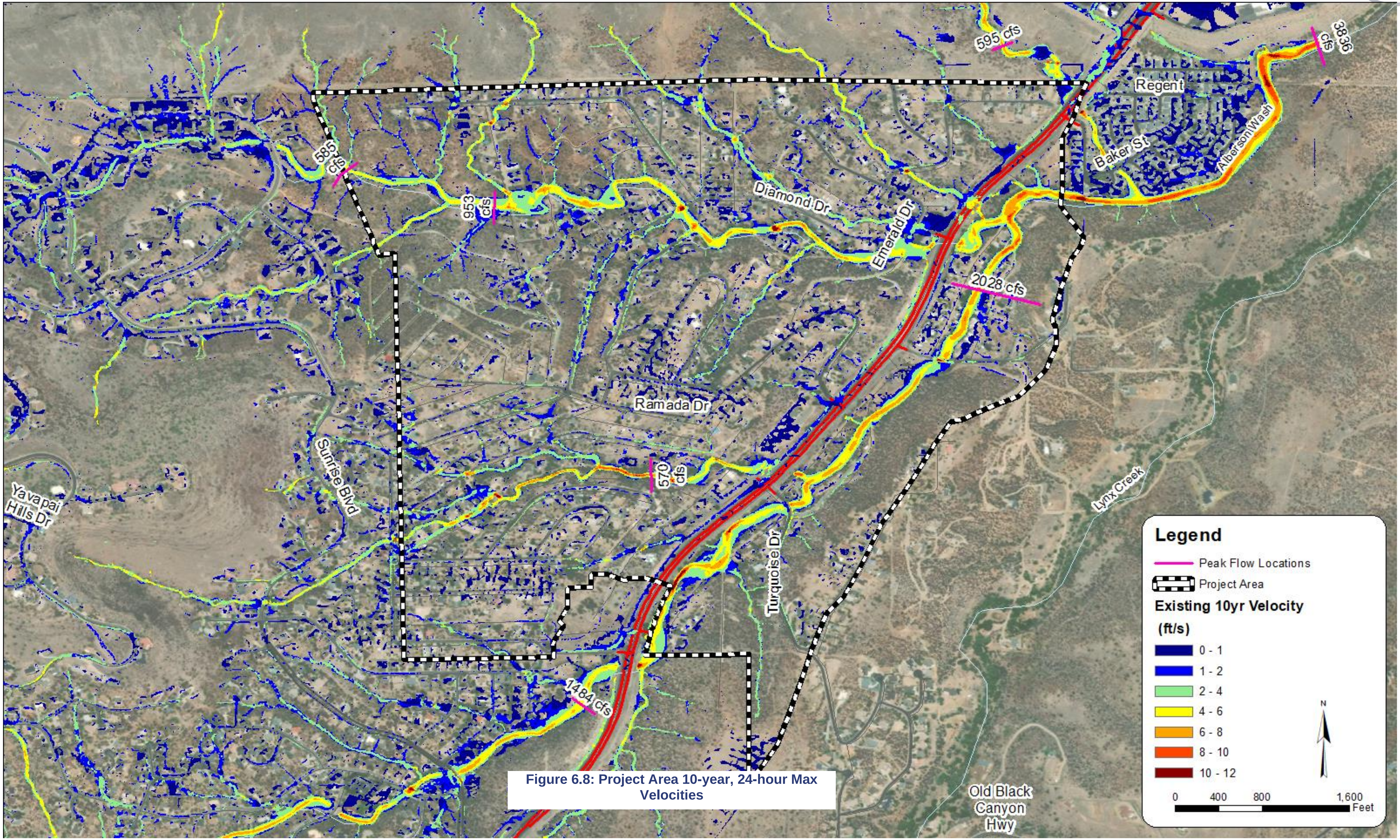


Figure 6.8: Project Area 10-year, 24-hour Max Velocities

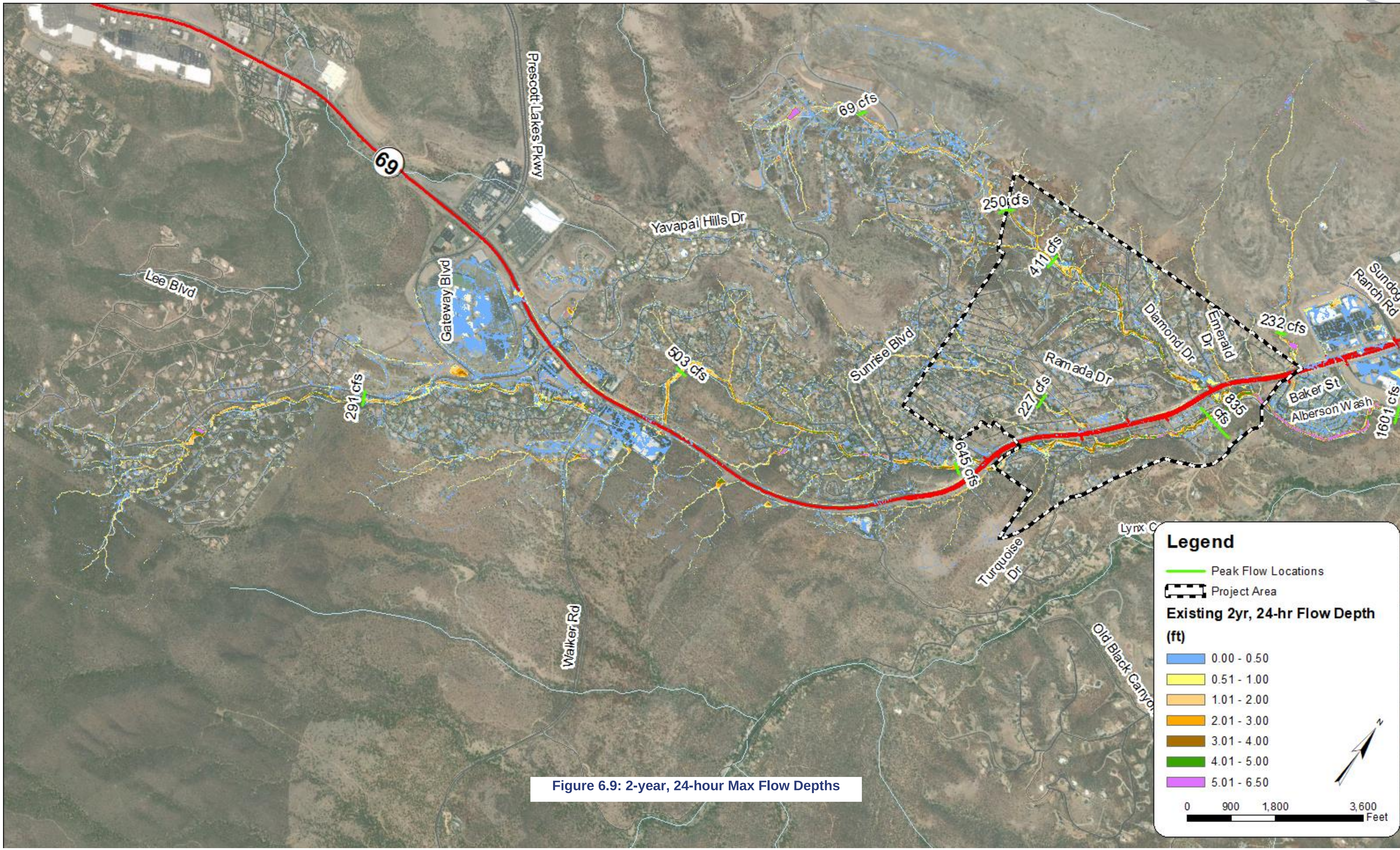


Figure 6.9: 2-year, 24-hour Max Flow Depths

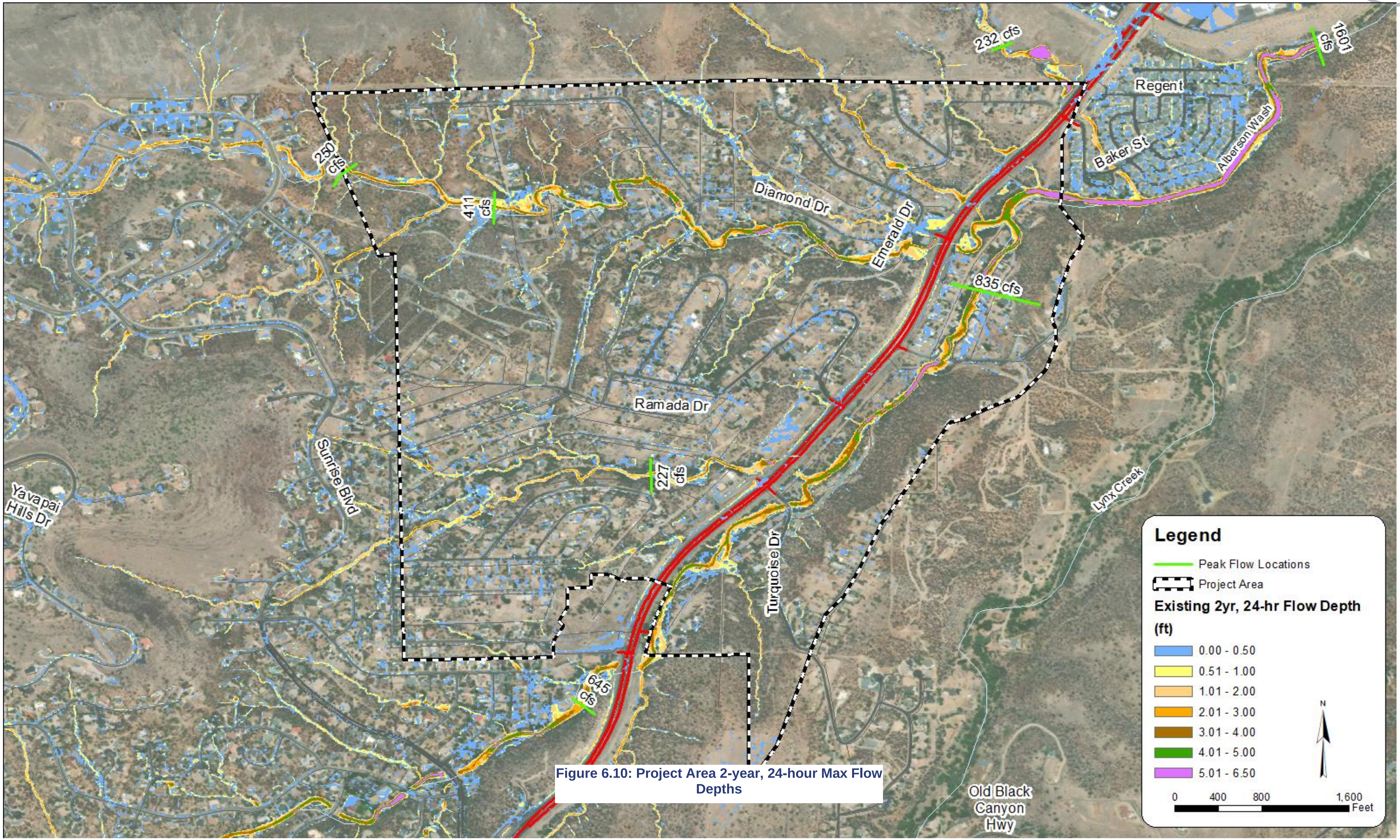


Figure 6.10: Project Area 2-year, 24-hour Max Flow Depths

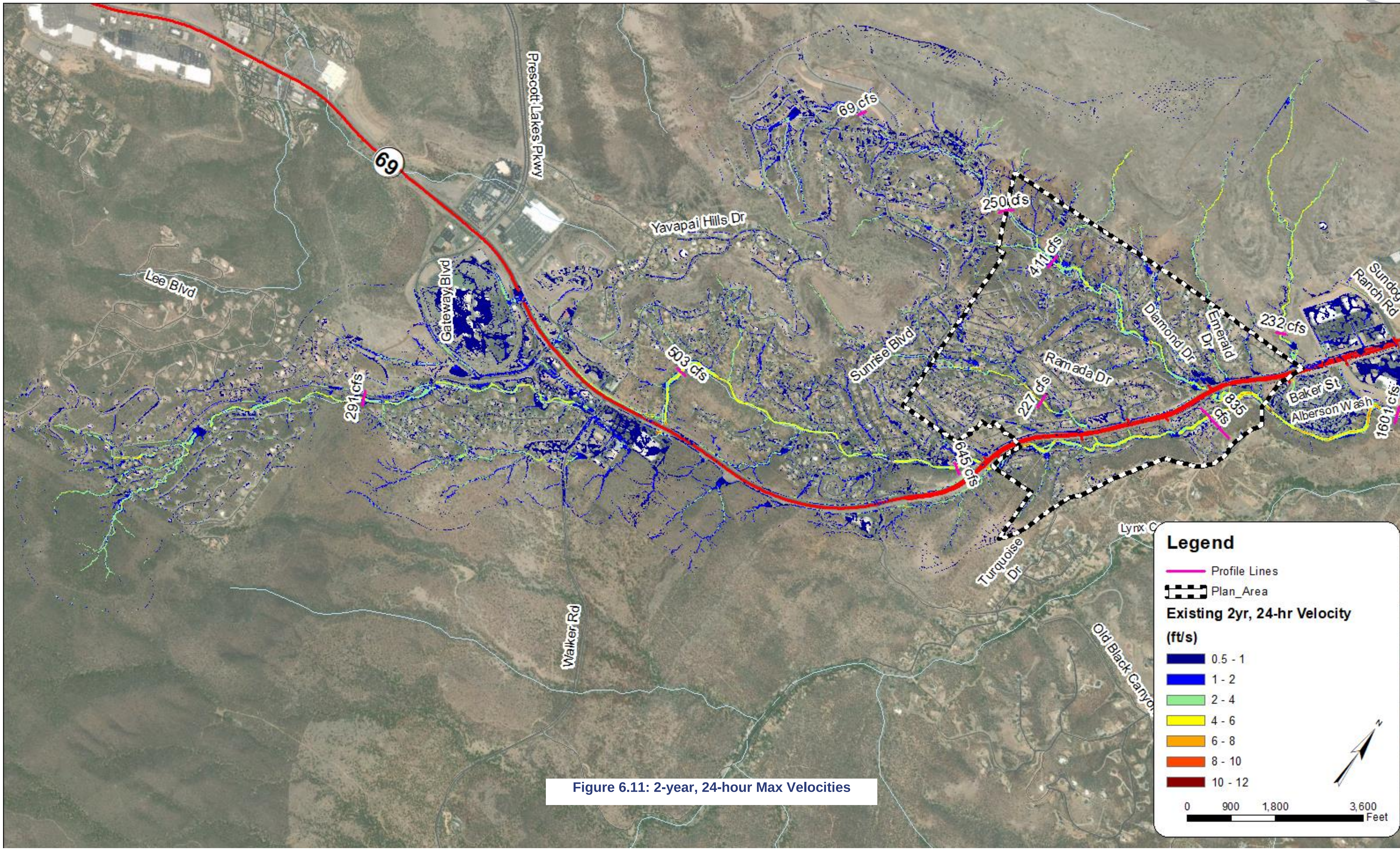


Figure 6.11: 2-year, 24-hour Max Velocities

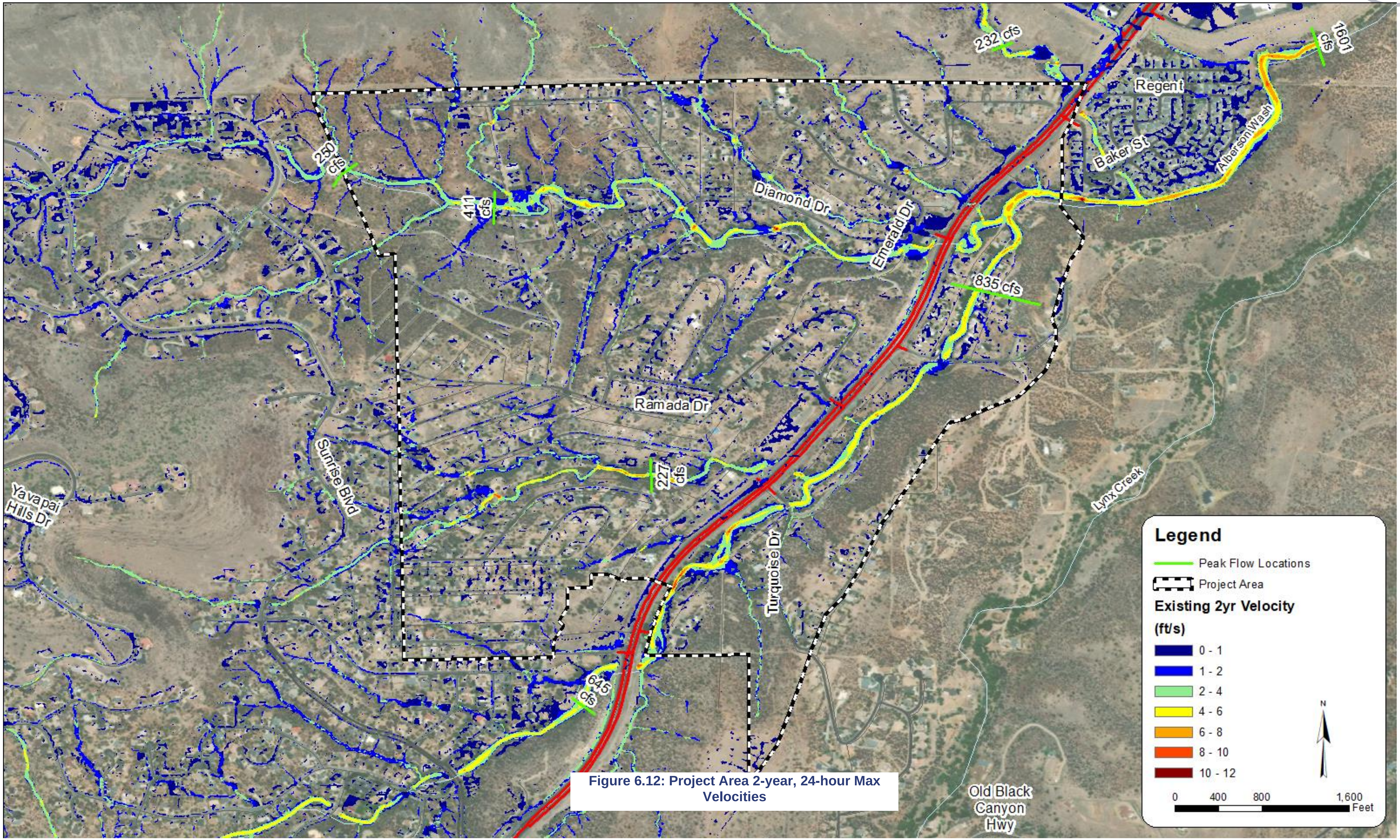


Figure 6.12: Project Area 2-year, 24-hour Max Velocities

7. Areas of Mitigation Interest (AOMIs)

Areas of Mitigation Interest were determined from public input and evaluated based on the HEC-RAS two-dimensional model depth and velocity results for the various storm events. Field visits and photos were also gathered to help identify and analyze these areas.

7.1 Public Input

Public Input was gathered from a survey that was mailed to residents. There were a total of 46 responses. The following table summarizes the responses received. The survey responses have been cataloged in Figure 7.1 showing the locations spatially within the Diamond Valley Watershed.

Table 7.1: Public Response Summary

Drainage Issue	No.
Structure Flooded from Wash	4
Structure Flooded from Local Issue	9
Other Local Flooding Issue	6
Wash Erosion	7
Road Flooding	16
Other Roadway Drainage Issue	4
Total	46

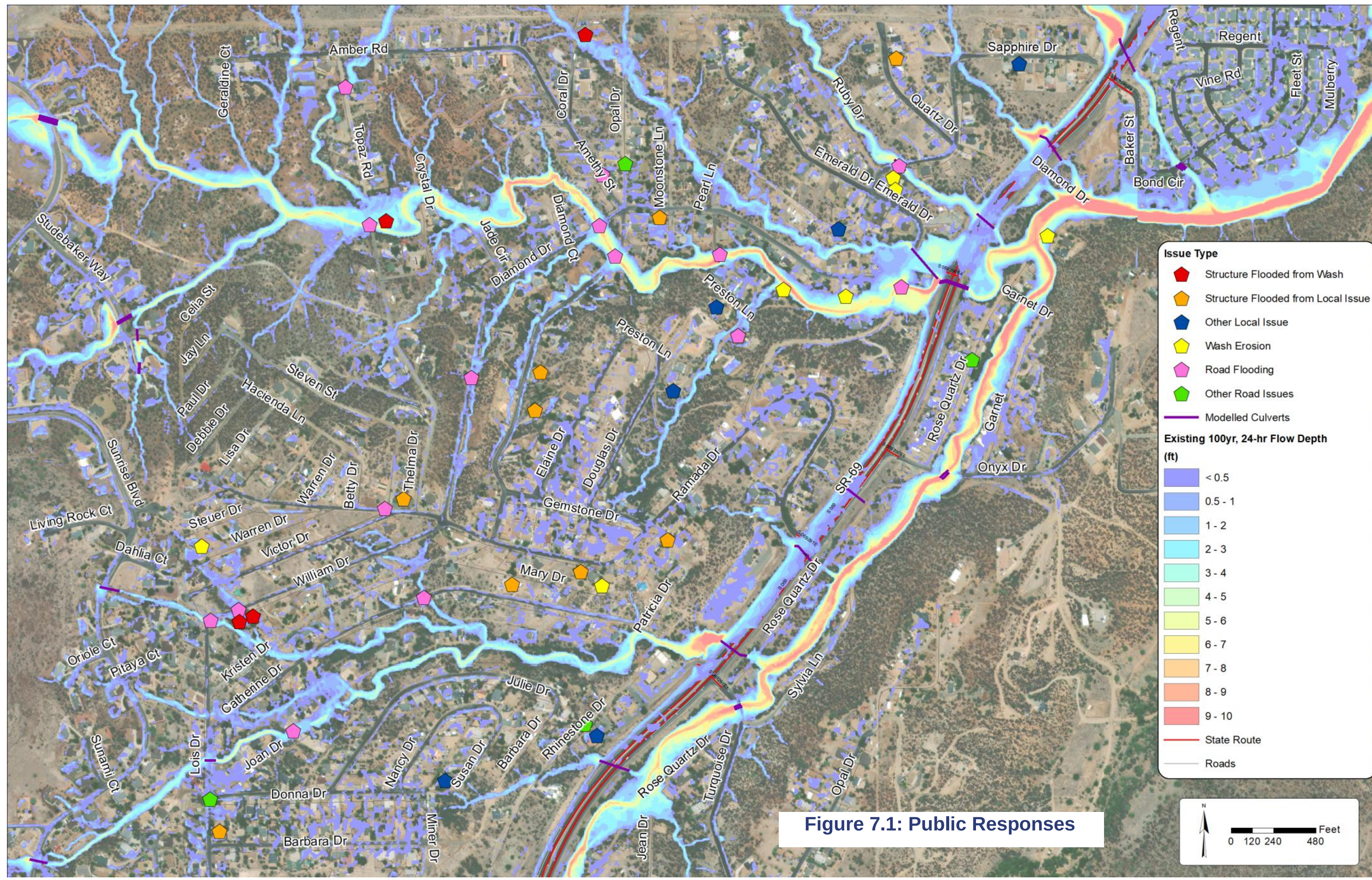
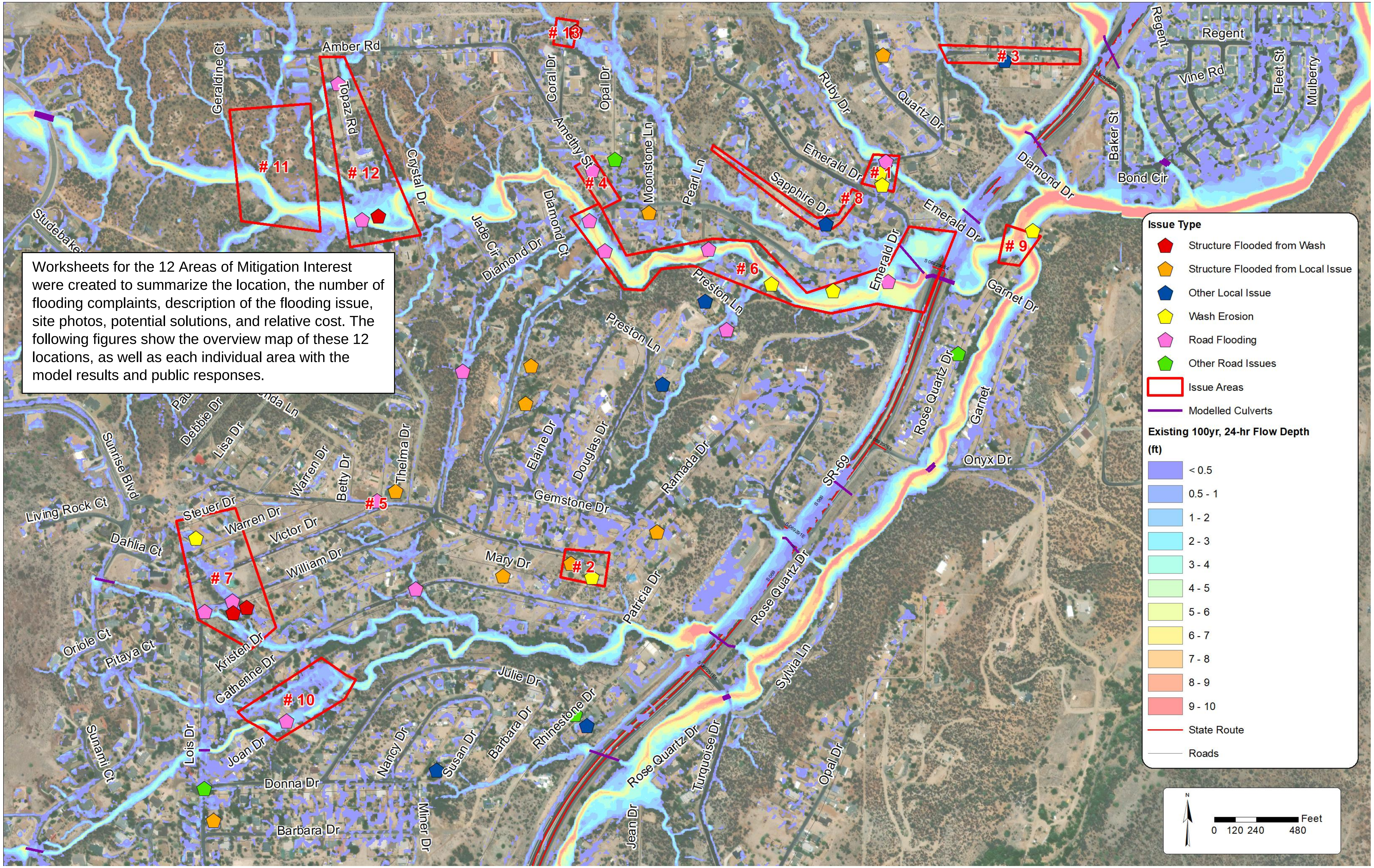


Figure 7.1: Public Responses

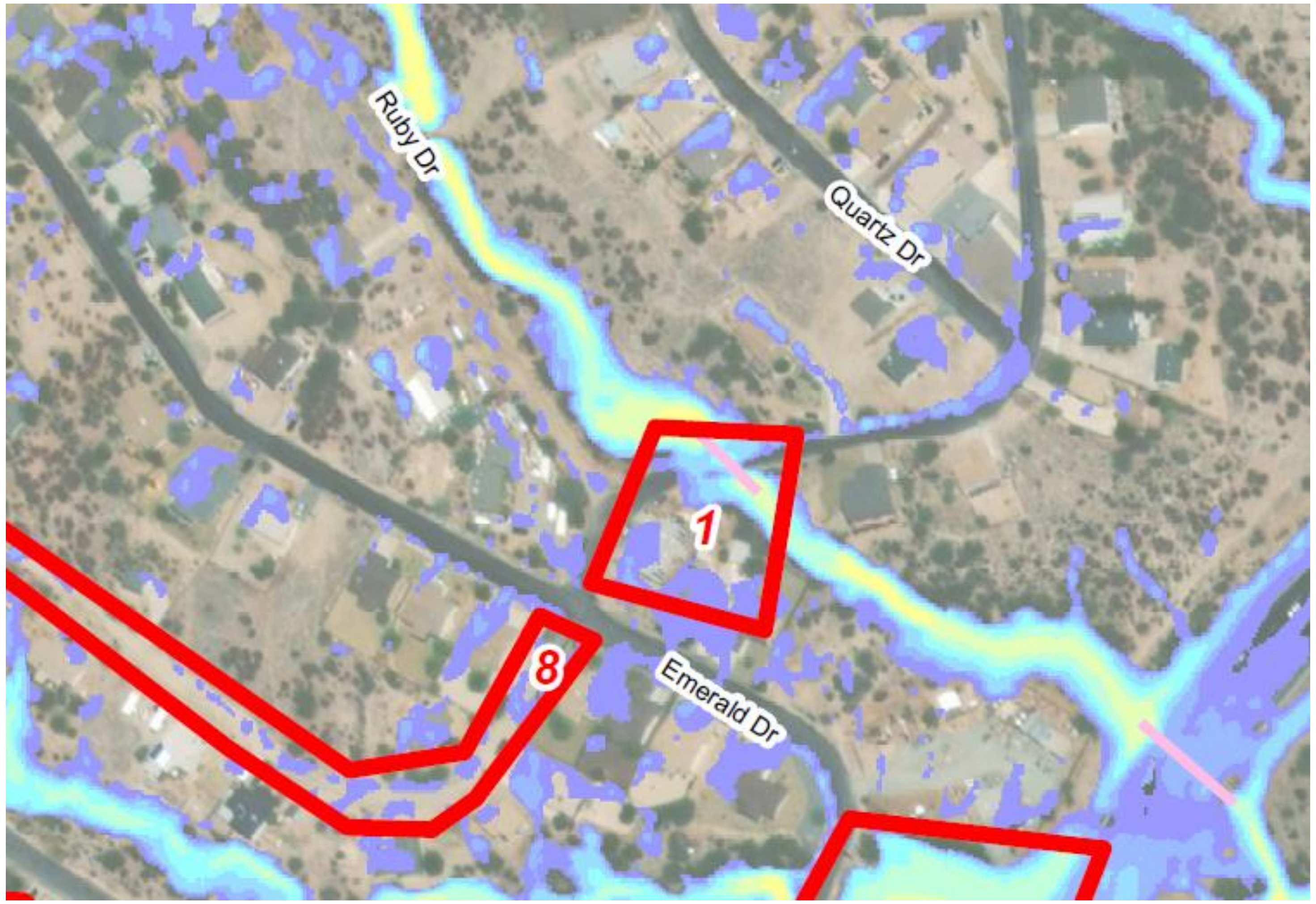
After reviewing the responses and assessing the flooding issues, the responses were then aggregated together based on proximity to each other and the potential to provide a mitigation solution that would address multiple public concerns. The responses were grouped together in 12 areas of mitigation interest.

7.2 Areas of Mitigation Interest (AOMIs)

Worksheets for the 12 Areas of Mitigation Interest were created to summarize the location, the number of flooding complaints, description of the flooding issue, site photos, potential solutions, and relative cost. The following figures show the overview map of these 12 locations, as well as each individual area with the model results and public responses.



AOMI #1



Location: Sapphire Dr near Ruby Dr

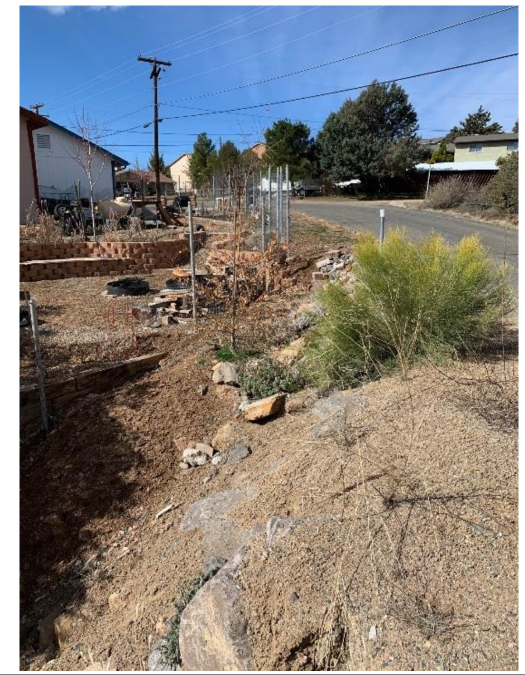
Number of Public Complaints: 5

Description: Flows in wash parallel to Ruby Dr appear to overtop Sapphire Dr during larger events. Larger flows may also breakout along Ruby Dr. These conditions lead to some runoff impacting the lot to the southwest of the culvert crossing along Sapphire Dr. Debris and sediment also get deposited in the roadway.

Potential Solutions: Upsize the culvert crossing, install rip rap roadway drainage swales to mitigate erosion issues.

Relative Cost: Low to medium

Field Observation:

Drainage path through lot SW of crossing (looking west)	Erosion along Sapphire Dr (looking east)
	
Upstream culvert entrance (looking south)	Erosion at upstream road edge at culvert (looking north)
	

AOMI #1 (Cont'd)

Flow path along Ruby Dr (looking northwest)

Erosion at corner of Ruby Dr and Sapphire Dr (looking north)

AOMI #2

Location: Ramada Dr

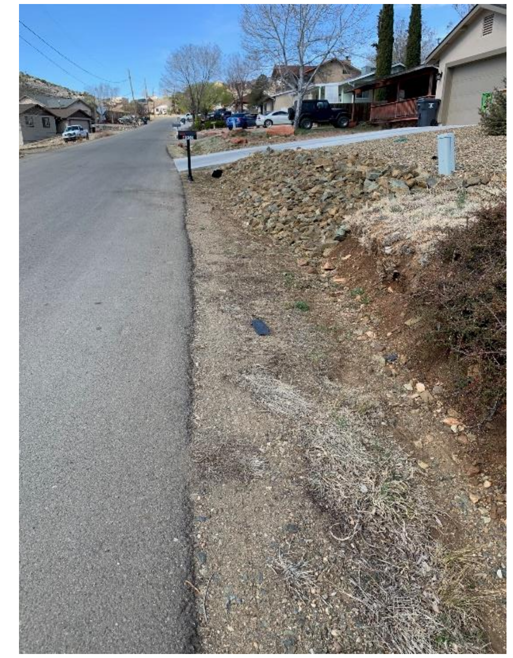
Number of Public Complaints: 2

Description: It appears two lots on downstream side of Ramada Dr are impacted during storm events. The likely cause is the limited capacity of driveway culverts on the north/upstream side of Ramada Dr due to damage and clogging.

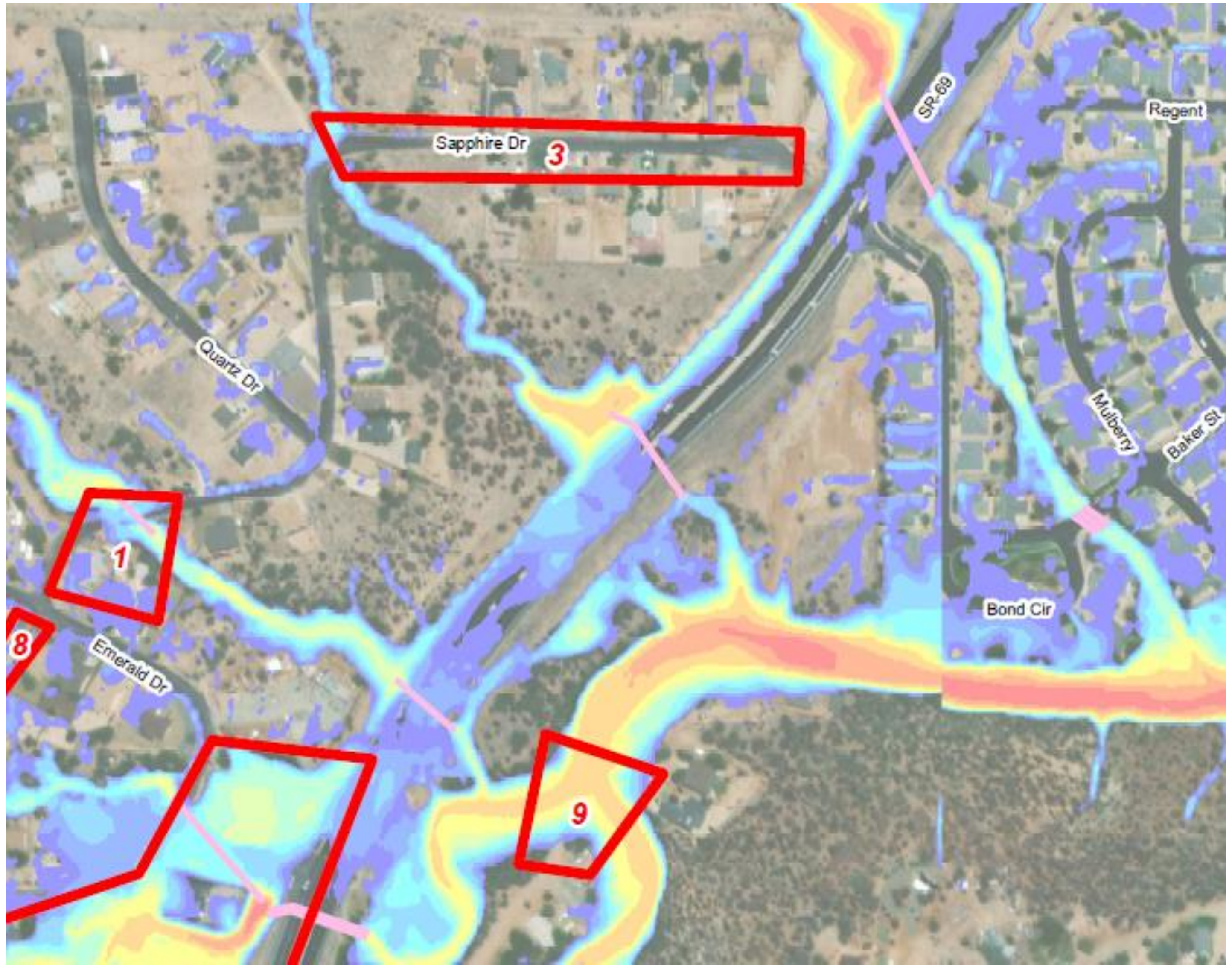
Potential Solutions: Fix or replace damaged or clogged driveway culverts.

Relative Cost: Low

Field Observation:

Roadside swale along Ramada Dr (looking west)	Ramada Dr (looking west)
	
Impacted lot on downstream side of road (looking south)	Damaged driveway culvert along Ramada Dr (looking north)
	

AOMI #3



Location: Sapphire Dr North

Number of Public Complaints: 1

Description: It appears runoff across Sapphire Dr impacts lots on the downstream side of the roadway. Downstream lots are lower than the road and there is no drainage infrastructure along Sapphire Dr.

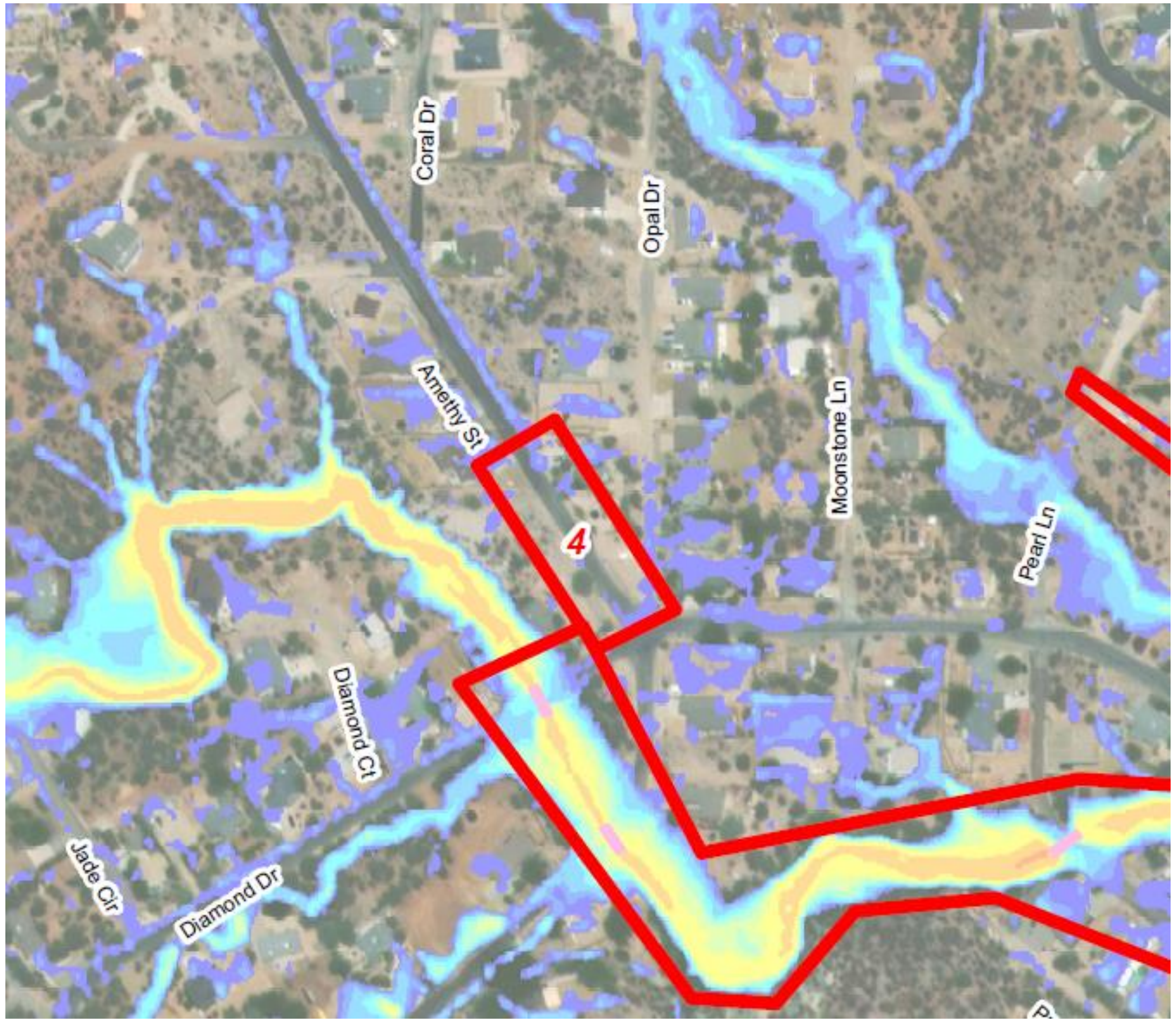
Potential Solutions: Construct a drainage swale on the north side of Sapphire Dr and/or an asphalt mountable curb on the south side routing flows to the east.

Relative Cost: Low

Field Observation:

Sapphire Dr (looking west)


AOMI #4



Location: Amber Road

Number of Public Complaints: 1

Description: Runoff along Amber Dr appears to be causing erosion and deposition issues adjacent and downstream of the roadway. Sediment deposition occurs at the five-way intersection.

Potential Solutions: Install road side swales and new culvert connecting to existing wash to the south.

Relative Cost: Low to medium

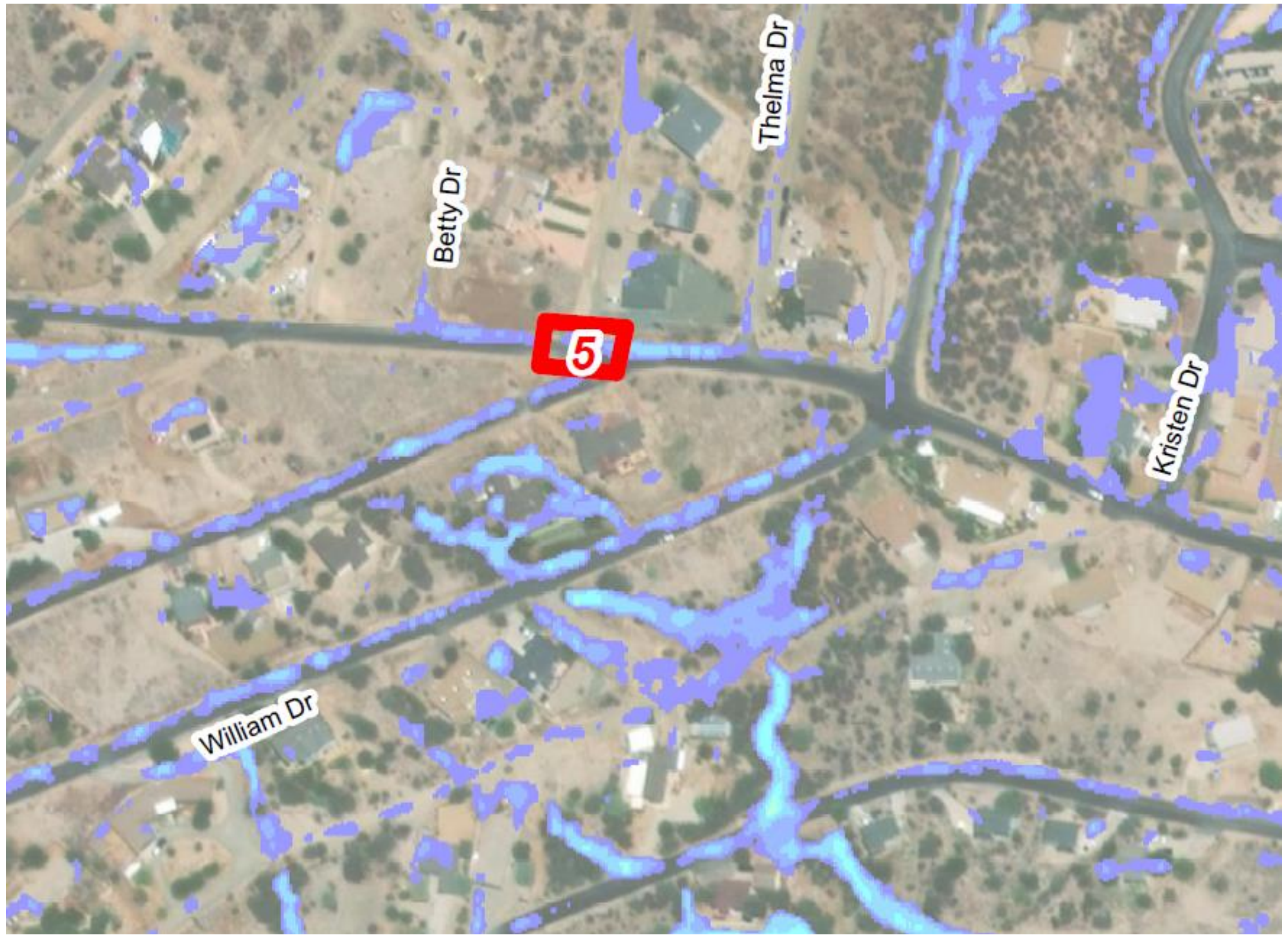
Field Observation:

Amber Dr (looking northwest)

AOMI #4 (Cont'd)

New culvert construction under Lapis Dr (looking south)

AOMI #5



Location: Ramada Dr North

Number of Public Complaints: 1

Description: It appears erosion and deposition occur adjacent to and downstream of Ramada Dr during storm events. Erosion occurs on the north side of the roadway, with deposition at the intersection with Diamond Dr.

Potential Solutions: Install rip rap road side swales with culverts under the Betty Dr, Victor Dr, and Thelma Dr.

Relative Cost: Low to medium

Field Observation:

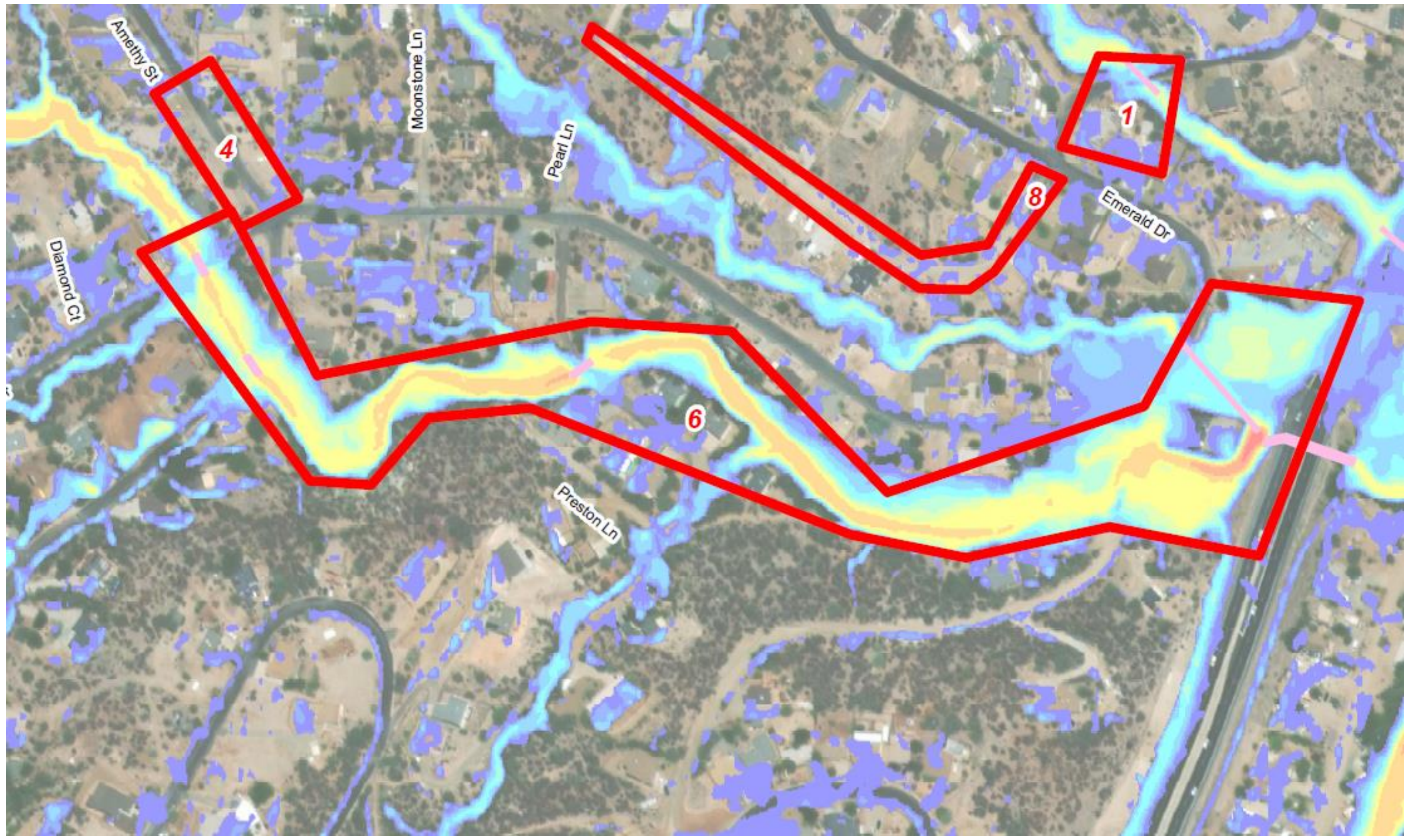
Diamond Dr outfall for Ramada Dr (looking north)	Ramada Dr (looking west)
	

AOMI #5 (Cont'd)

Ramada Dr upstream of Diamond Dr (looking east)	Ramada Dr at Diamond Dr (looking east)
	

Intersection of Ramada Dr and Diamond Dr (looking west)


AOMI #6



Location: Main Diamond Valley area wash

Number of Public Complaints: 14

Description: The main wash in Diamond Valley creates flooding issues for residents during larger storm events mainly due to undersized road crossings at Diamond Dr and Pearl Ln. In addition, higher flows can cause erosion issues for residents adjacent to the wash. The Pearl Ln area experiences frequent impacts during runoff events since the road is unpaved.

Potential Solutions: Improve crossings at Diamond Dr and Pearl Ln, armor Pearl Ln crossing, isolated channel improvements, upstream detention.

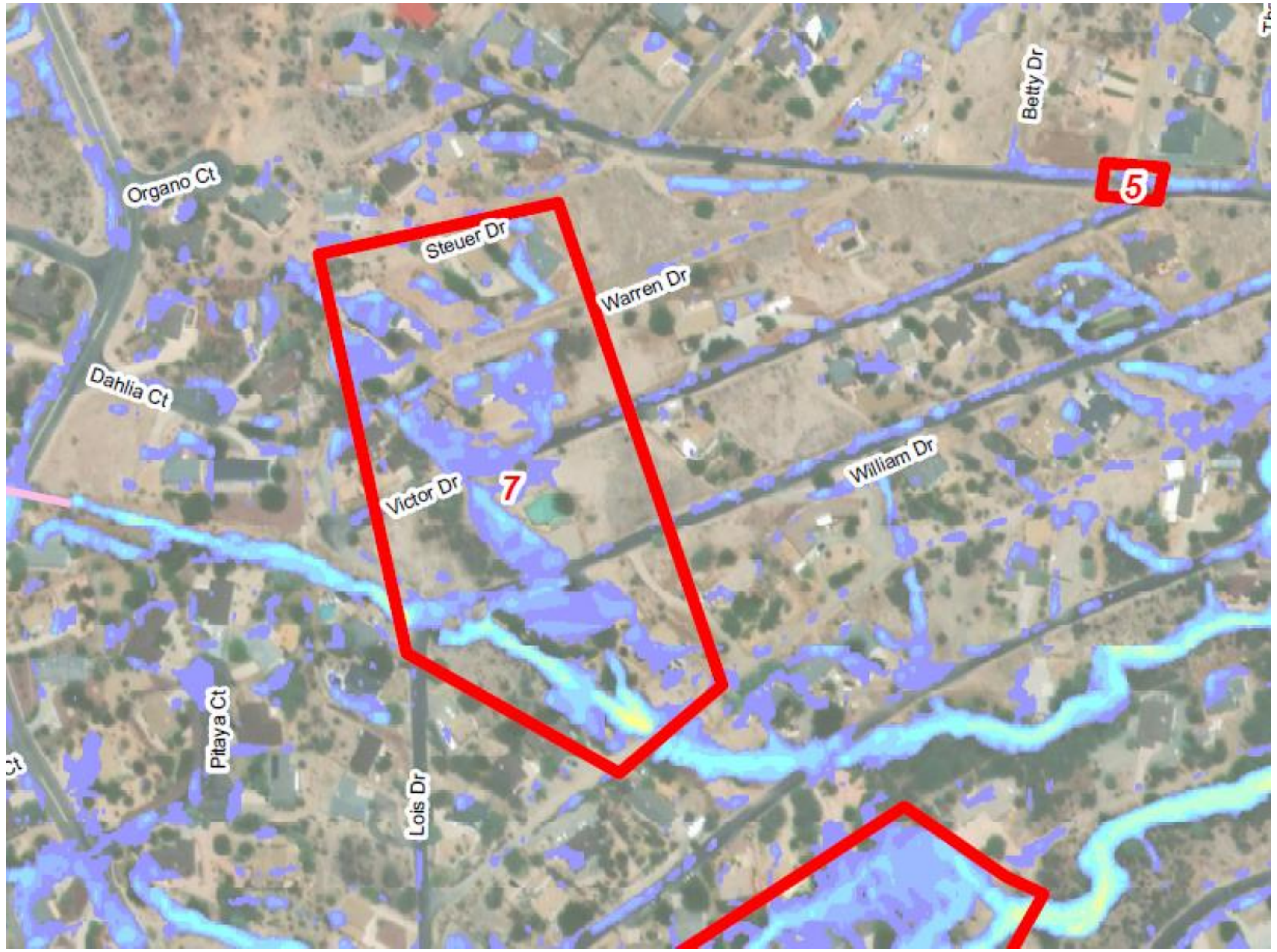
Relative Cost: Low to high

Field Observation:

Diamond Dr wash crossing (looking southwest)

Pearl Ln with wash crossing in distance (looking south)

AOMI #7



Location: Williams Dr at Lois Dr

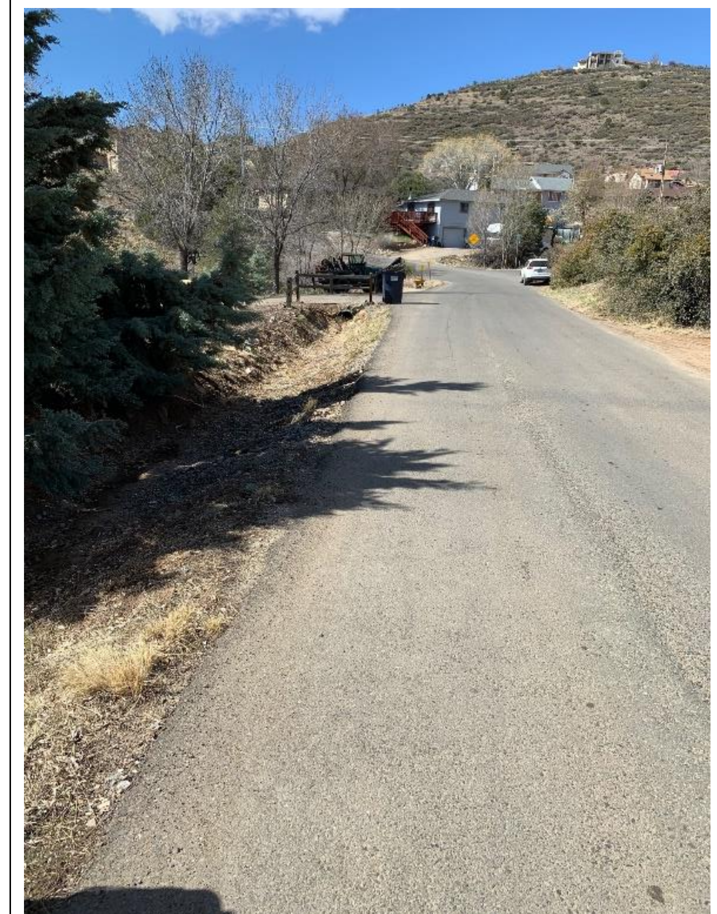
Number of Public Complaints: 3

Description: Runoff upstream of Williams Dr crosses the road and impacts lots on the downstream side. These lots are lower than the road. There is an existing drainage swale that is overwhelmed during larger events.

Potential Solutions: Increase capacity of swale conveying runoff to the wash to the southwest or reroute runoff upstream of Williams Dr.

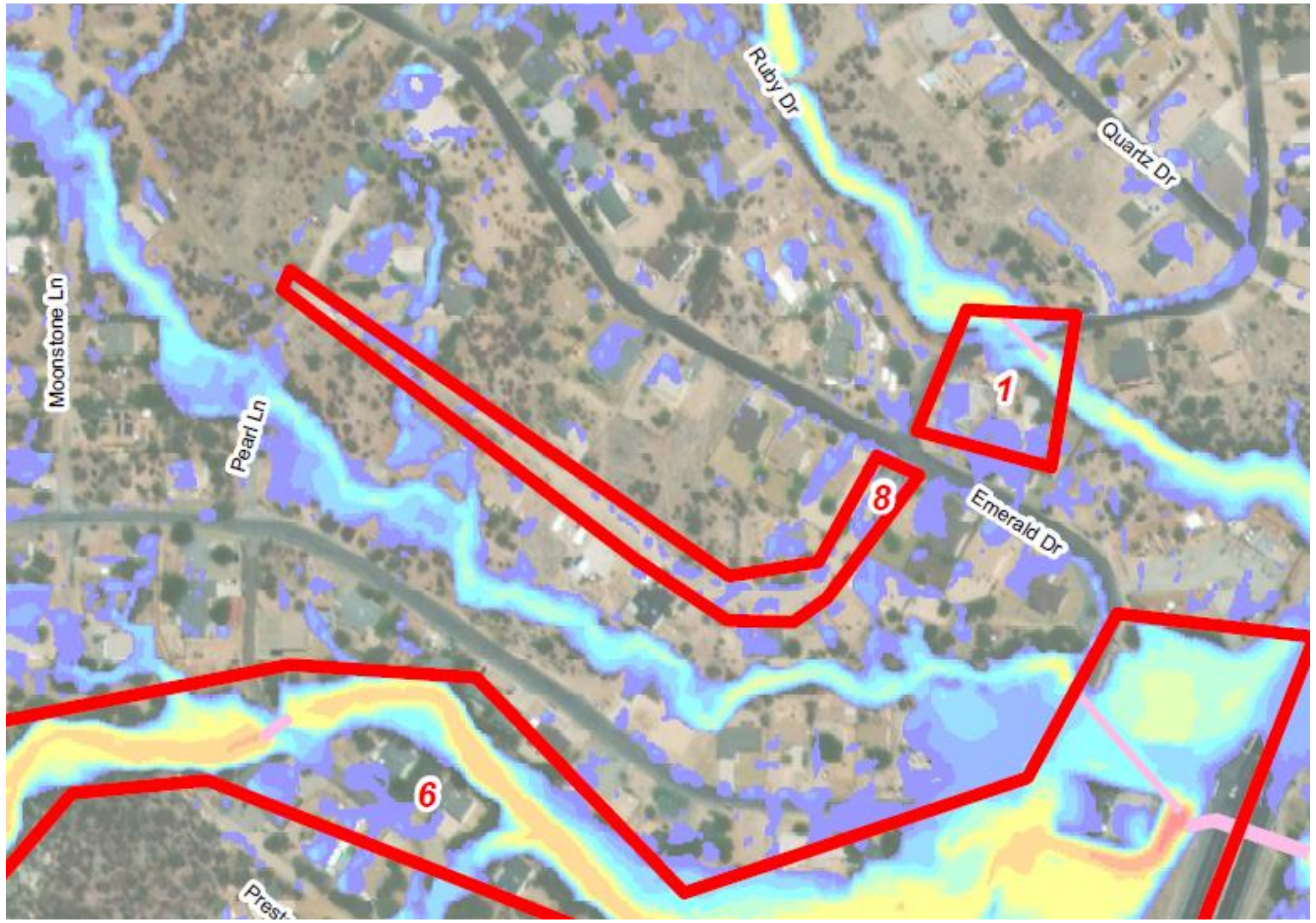
Relative Cost: Low to medium

Field Observation:

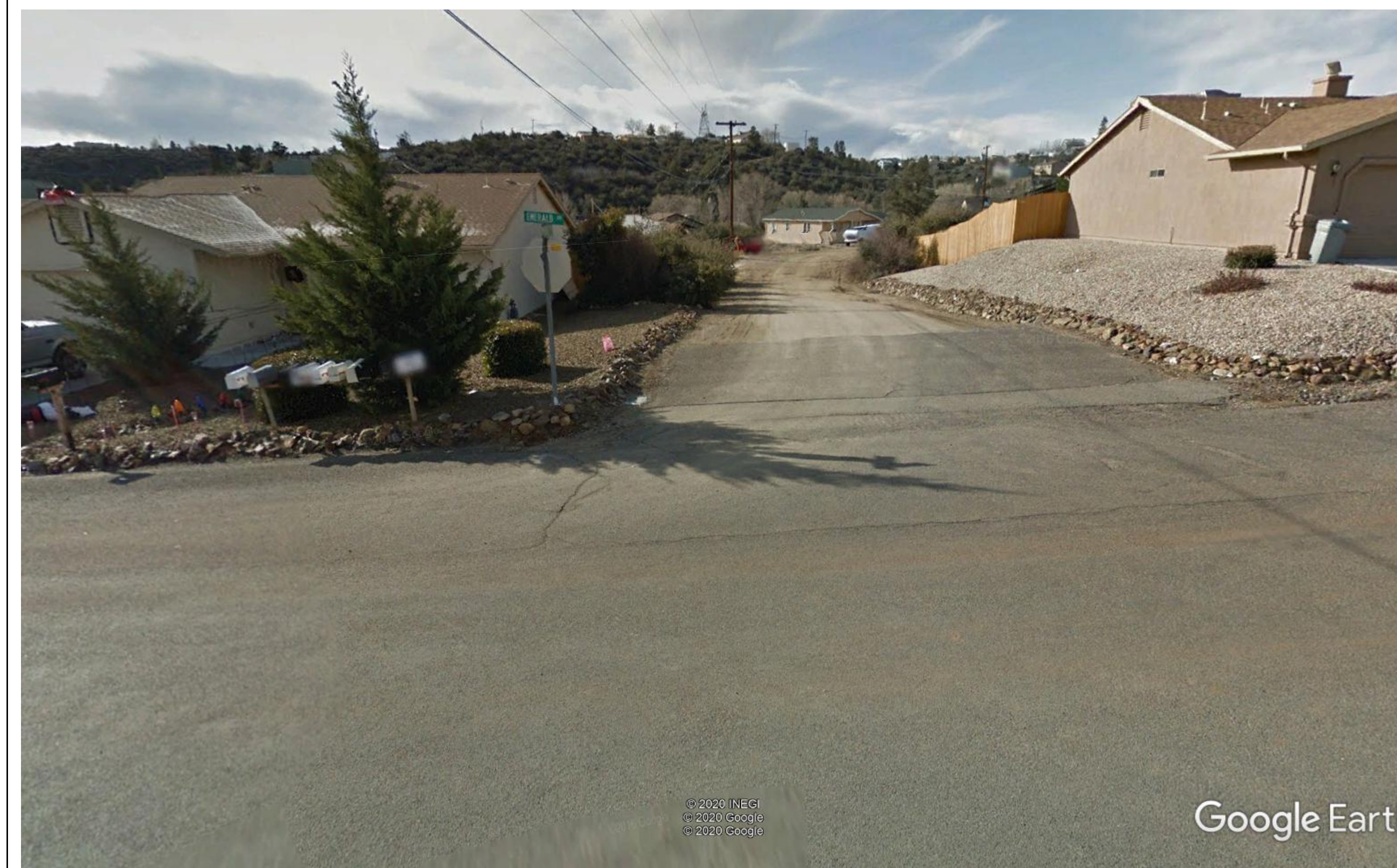
Upstream lot from Williams Dr (looking northwest)	Williams Dr (looking southwest)
	

Williams Dr (looking southwest)

AOMI #8



Field Observation:

Sapphire Dr at Emerald Dr (looking southwest)


Location: Sapphire Dr unpaved section

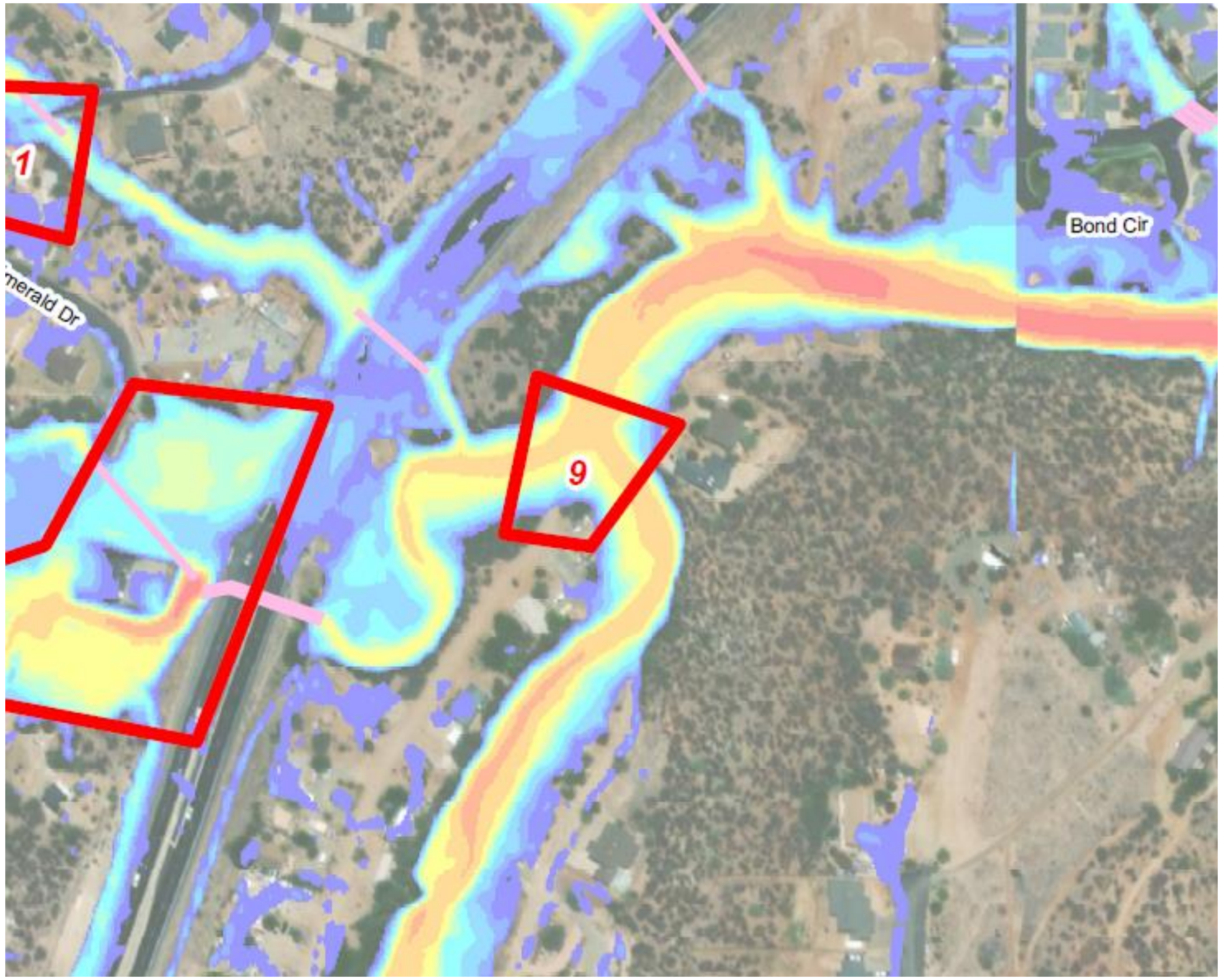
Number of Public Complaints: 1

Description: The unpaved portion of Sapphire Dr experiences erosion, rilling, and ponding during runoff events.

Potential Solutions: Rip rap road side swales and paving the road.

Relative Cost: Low to high

AOMI #9



Location: Rose Quartz Dr and Alberson Wash

Number of Public Complaints: 1

Description: Alberson Wash is a significant water course with FEMA designated floodplain. The property immediately adjacent to the crossing at Rose Quartz Dr experiences erosion to their driveway during large runoff events. This limits access until repaired.

Potential Solutions: Extend concrete at-grade crossing protection above 100-year water surface elevation or improve crossing with 100-year culverts.

Relative Cost: Low to high

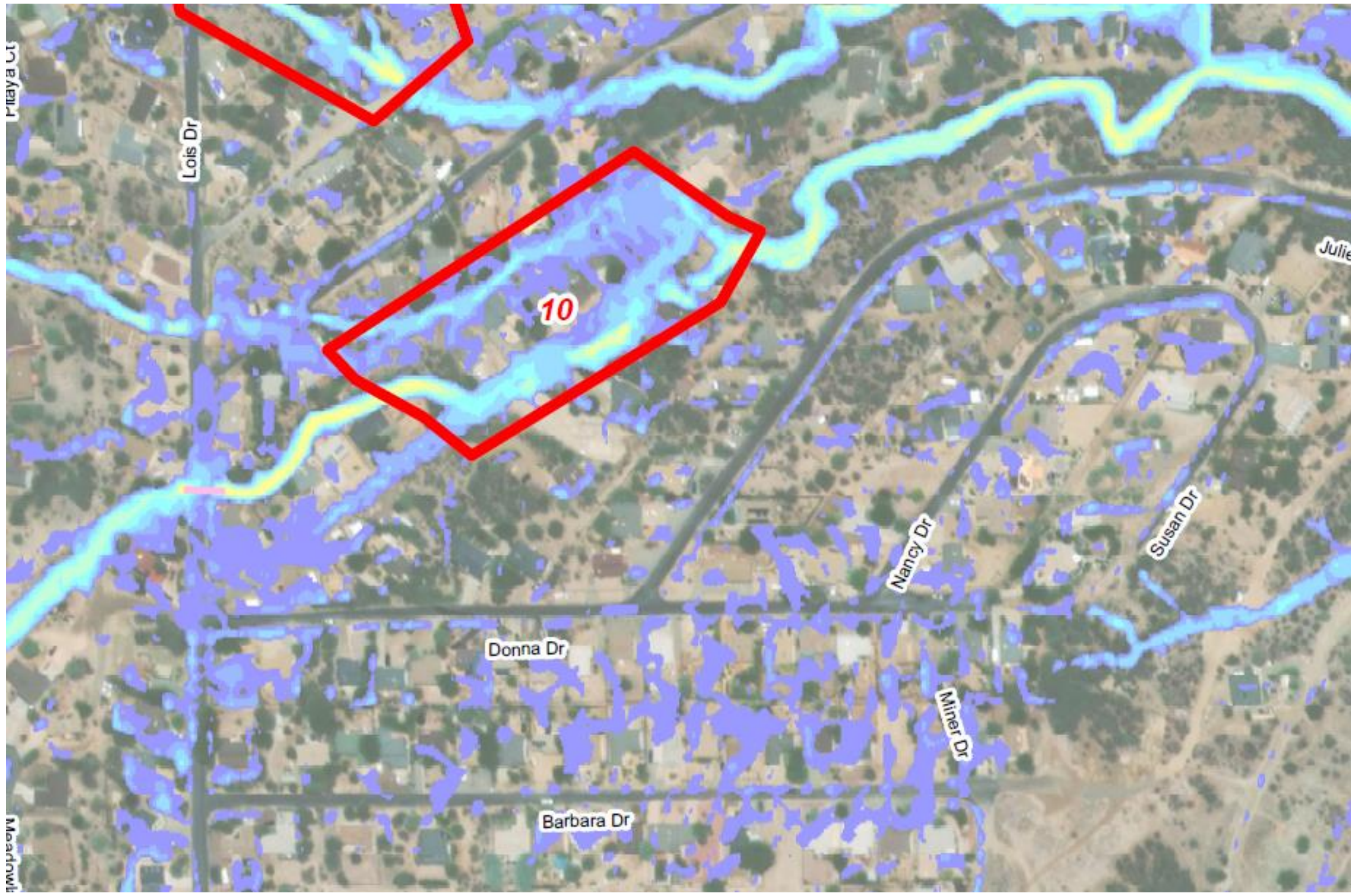
Field Observation:

Alberson Wash at Rose Quartz Dr (looking southeast)	Right over bank/driveway (looking north)
	
Wash crossing and left over bank (looking south)	Right channel bank (looking north)
	

AOMI #9 (Cont'd)

Alberson Wash crossing at Rose Quartz Dr (looking south)

AOMI #10



Location: Joan Dr

Number of Public Complaints: 1

Description: Flow from the adjacent wash breaks out and flows down Joan Dr. The wash crosses Joan Dr in several locations at-grade. Joan Dr is unpaved in this location.

Potential Solutions: Reprofile Joan Dr and add culverts at the wash crossing locations. Possibly reroute wash to minimize crossings. Could armor existing at-grade crossings as interim fix.

Relative Cost: High

Field Observation:

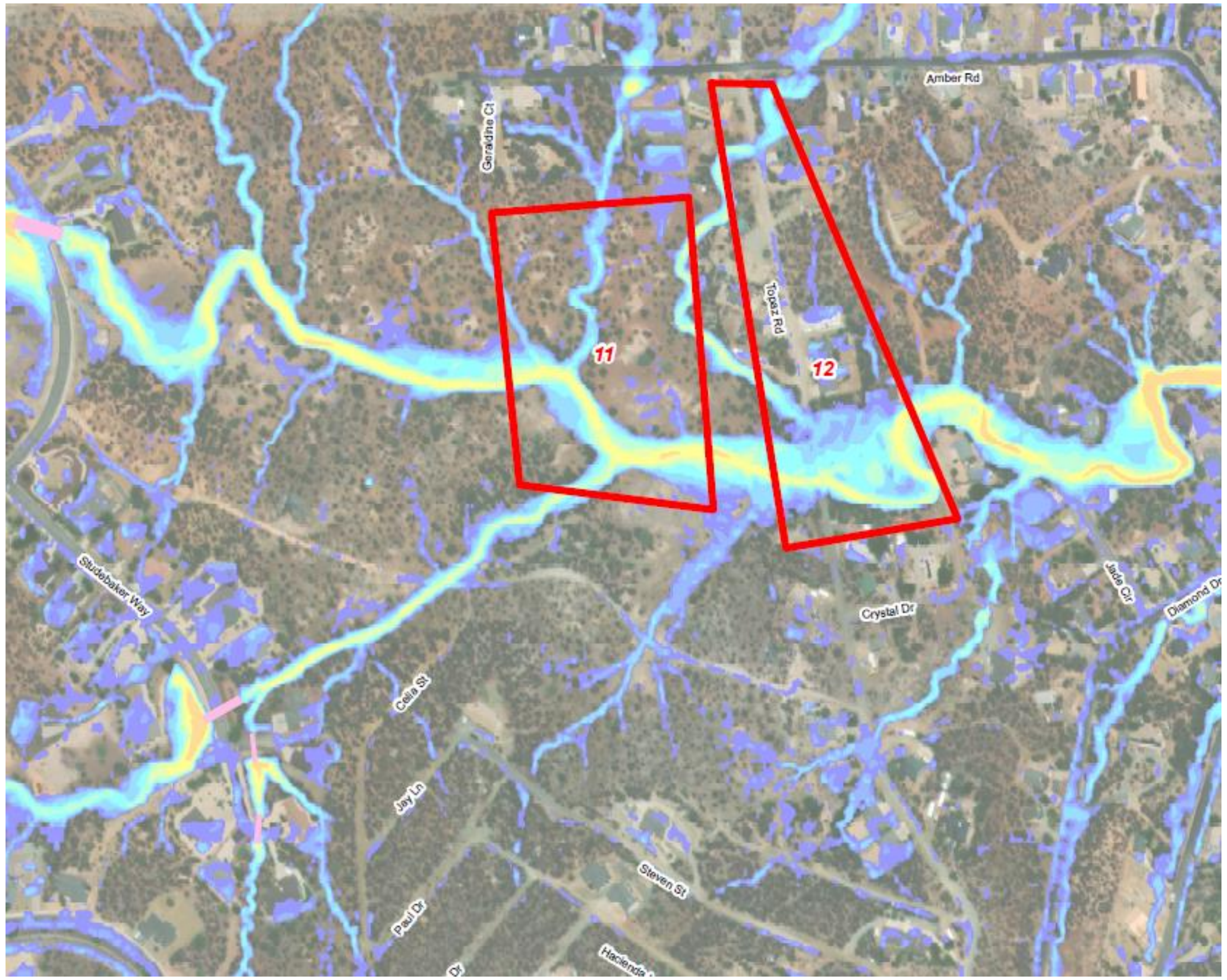
Joan Dr at Lois Dr (looking northeast)	First wash crossing on Joan Dr (looking northeast)
	
First wash crossing on Joan Dr (looking southwest)	Second wash crossing on Joan Dr (looking northeast)
	

AOMI #10 (Cont'd)

Second wash crossing downstream of road (looking west)	Culverts for wash under driveway (looking southwest)
	

Breakout flow down Joan Dr (looking northeast)


AOMI #11



Location: Detention upstream of Topaz Dr

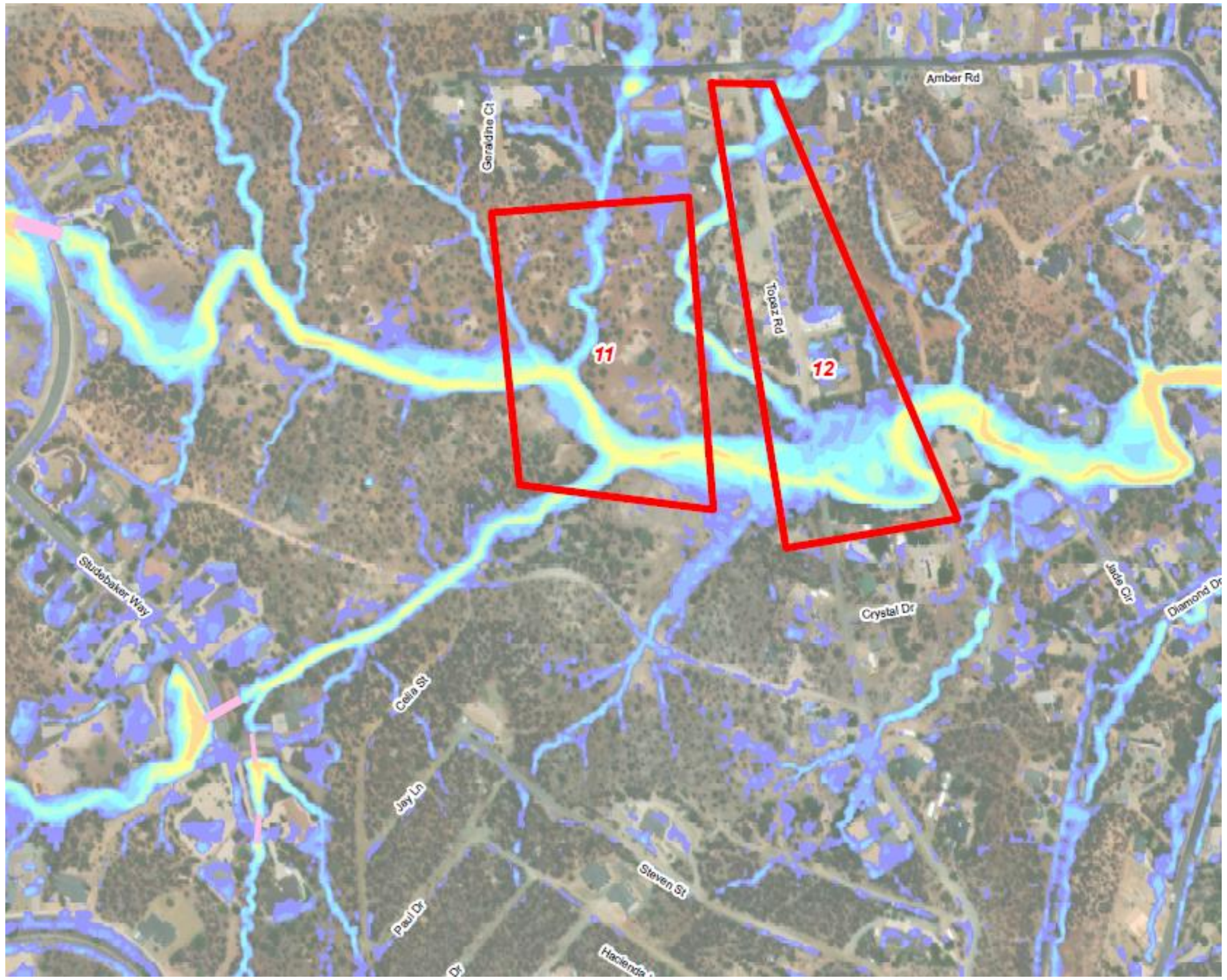
Number of Public Complaints: 16

Description: A detention basin constructed to detain runoff from the Yavapai Hill subdivision could be affective in mitigating the flooding issues associated with drainage Issues #6, #12, and the final design project at Emerald Dr and Hwy 69.

Potential Solutions: Construct 100-year detention basin on State land upstream of Topaz Dr

Relative Cost: High

AOMI #12



Location: Wash crossing at Topaz Dr

Number of Public Complaints: 2

Description: The main wash in the Diamond Valley area downstream of Topaz Dr meanders several times near Crystal Dr. The upstream meander is causing severe erosion at Crystal Dr. The property immediate north of the wash also gets inundated during large storm events.

Potential Solutions: Construct channel and bank improvements downstream of Topaz Dr

Relative Cost: Medium

Field Observation:

Wash upstream of Topaz Dr (looking west)	Wash downstream of Topaz Dr (looking east)
	
Left over bank area downstream of Topaz Dr (looking north)	Cut bank where wash bends at Crystal Dr (looking east)
	

AOMI #12 (Cont'd)

Cut bank where wash bends at Crystal Dr (looking northeast)	Downstream of cut bank (looking north)
	

Cut bank where wash bends at Crystal Dr (looking east)


8. Selection of Preferred Alternatives

The 12 Areas of Mitigation Interest were prioritized based on the number of potential structures benefited, the severity of the flooding adjacent to the structures, the number of public responses, traffic impacts, business impacts, land ownership, existing development, and relative costs of the mitigation alternatives. The decision matrix is shown on the following page.

Table 8.1: Decision Matrix

Exhibit ID	Name	No. of Potential Structures Benefited	No. Structures > 0.5 ft in the 100-year storm	No. Structures > 1 ft in the 100-year storm	Relevant Storm Frequencies	Public Responses	Impacts Traffic Flow?	Impacts Businesses?	Improvements on Public or Private Land?	Parcels Developed?	Potential Cost?	Notes
1	Sapphire Dr culvert crossing near Ruby Dr	2	0	0	100	5	y	n	County/Private	Yes	$	
2	Ramada Dr maintain/replace driveway culverts	2	?	?	?	2	n	n	County/Private	Yes	$	May be fixed with maintenance, recent issue after model data
3	Asphalt berm for low side of Sapphire Dr	1	0	0	?	1	n	n	County		$	
4	Culvert under Amber Rd	1	0	0	10, 100	1	n	n	County		$	
5	Culvert under Victor Dr, Betty Dr, and Thelma Dr	0	0	0	100	1	y	n	County		$	
6	Culverts along wash ending at Diamond Dr and Emerald Dr	2	1	1	all	14	y	y	County		$ -$$$	Scalable depending on how many crossings are improved
7	Wash improvements near Lois Dr and William Dr	3	2	0	all	3	y	n	County/Private	Both	$$	
8	Unpaved Sapphire Dr improvements	1	0	0	all	1	n	n	County		$$	
9	Improve/protect wash confluence at Rose Quartz Dr	1	0	0	all	1	y	n	County		$$ -$$$	Could impact floodplain, triggering FEMA
10	Joan Dr and nearby wash	5	4	2	all	1	y	n	County/Private	Yes	$$$	
11	Detention basin upstream of Topaz Dr	4	3	3	all	16	y	y	State Land		$$$	
12	Improve crossings and wash crossing Topaz Dr	3	2	2	all	2	y	n	County/Private	No	$$$	Could be less if flooding condition is improved instead of resolved

From the worksheets, decision matrix, and discussion with the County, five areas were selected as preferred alternatives for further mitigation solution refinement and project cost estimating. These five areas are listed in Table 8.2. AOMI #13 was added after the decision matrix had been completed as a wash bank stabilization project to protect an existing roadway per County direction.

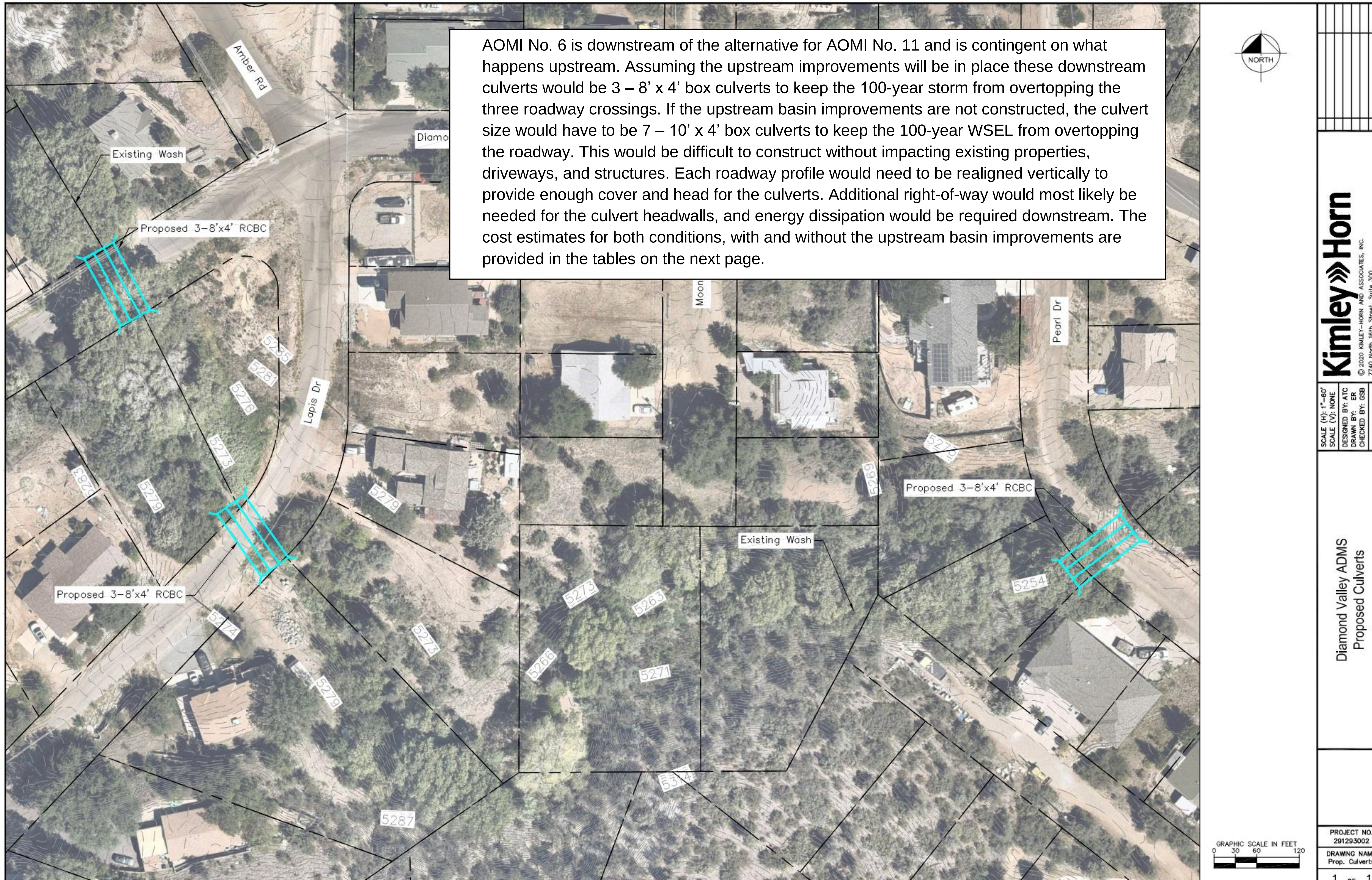
Table 8.2: Preferred Alternatives

AOMI ID	Name
6	Culverts along wash ending at Diamond Dr and Emerald Dr
7	Wash improvements near Lois and William Dr
10	Joan Dr and nearby wash
11 & 12	Detention basin upstream of Topaz Dr and crossing improvement at Topaz Dr
13	Wash bank stabilization along Rose Quartz Rd

9. Preliminary Design Concepts for Alternatives

9.1 AOMI #6 Culverts at Lapis Dr, Diamond Dr, and Pearl Dr

AOMI No. 6 is downstream of the alternative for AOMI No. 11 and is contingent on what happens upstream. Assuming the upstream improvements will be in place these downstream culverts would be 3 – 8' x 4' box culverts to keep the 100-year storm from overtopping the three roadway crossings. If the upstream basin improvements are not constructed, the culvert size would have to be 7 – 10' x 4' box culverts to keep the 100-year WSEL from overtopping the roadway. This would be difficult to construct without impacting existing properties, driveways, and structures. Each roadway profile would need to be realigned vertically to provide enough cover and head for the culverts. Additional right-of-way would most likely be needed for the culvert headwalls, and energy dissipation would be required downstream. The cost estimates for both conditions, with and without the upstream basin improvements are provided in the tables on the next page.



Kimley»Horn

Project: *Diamond Valley Area Drainage Master Plan*
Location **#6 - Culverts at Diamond Dr., Lapis Rd., and Pearl Dr. with Upstream Basins (#11)**
Level of Protection **100-year**
Designed by: **ATC** Date: 9/1/2020
Checked by: **GSB** Date: 9/1/2020

Item Description	Unit	Unit Price	Qty	Cost
Riprap Outlet Protection	CY	$ 120	3,000	$ 360,000
Headwalls	EA	$ 25,000	6	$ 150,000
3 - 8'x4' RCBC	LF	$ 2,500	330	$ 825,000
Utility Conflict	EA	$ 30,000	6	$ 180,000
Drainage Easement	SF	$ 5.00	6,000	$ 30,000
Construction Subtotal				$ 1,545,000
Removals (5%)				$ 77,250
Miscellaneous Construction Costs (30%)[1]				$ 463,500
Contingency (20%)				$ 309,000
CONSTRUCTION TOTAL				**$ 2,394,750**
Final Design (10%)				$ 239,475
Permitting (5%)				$ 119,738
PLANNING/DESIGN TOTAL				**$ 359,213**
TOTAL PROJECT COST				**$ 2,750,000**

(1) Includes Mobilization, Traffic Control, Construction Staking, Quality Control, SWPPP, and Construction Management

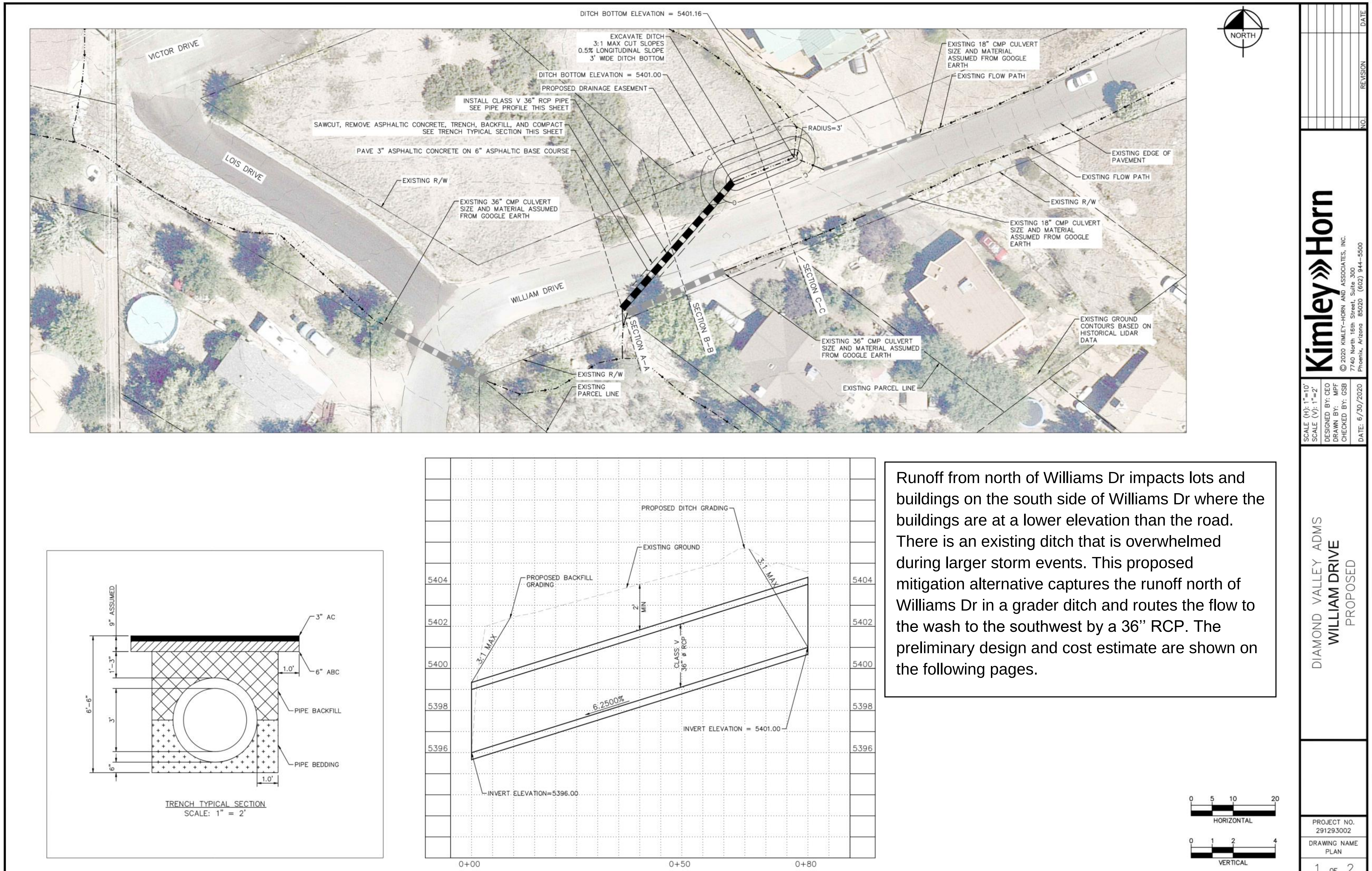
Kimley»Horn

Project: *Diamond Valley Area Drainage Master Plan*
Location **#6 - Culverts at Diamond Dr., Lapis Rd., and Pearl Dr. without Upstream Basins (#11)**
Level of Protection **100-year**
Designed by: **ATC** Date: 9/1/2020
Checked by: **GSB** Date: 9/1/2020

Item Description	Unit	Unit Price	Qty	Cost
Riprap Outlet Protection	CY	$ 120	8,400	$ 1,008,000
Headwalls	EA	$ 35,000	6	$ 210,000
7 - 10'x4' RCBC	LF	$ 7,600	330	$ 2,508,000
Utility Conflict	EA	$ 30,000	6	$ 180,000
Drainage Easement	SF	$ 5.00	12,000	$ 60,000
Construction Subtotal				$ 3,966,000
Removals (5%)				$ 198,300
Miscellaneous Construction Costs (30%)[1]				$ 1,189,800
Contingency (20%)				$ 793,200
CONSTRUCTION TOTAL				**$ 6,147,300**
Final Design (10%)				$ 614,730
Permitting (5%)				$ 307,365
PLANNING/DESIGN TOTAL				**$ 922,095**
TOTAL PROJECT COST				**$ 7,070,000**

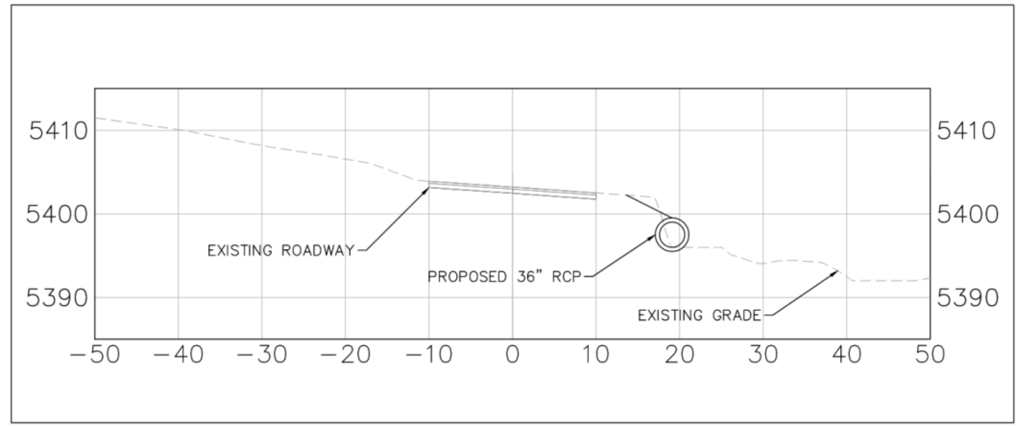
(1) Includes Mobilization, Traffic Control, Construction Staking, Quality Control, SWPPP, and Construction Management

9.2 AOMI #7 Wash Improvements Near Lois Dr and William Dr

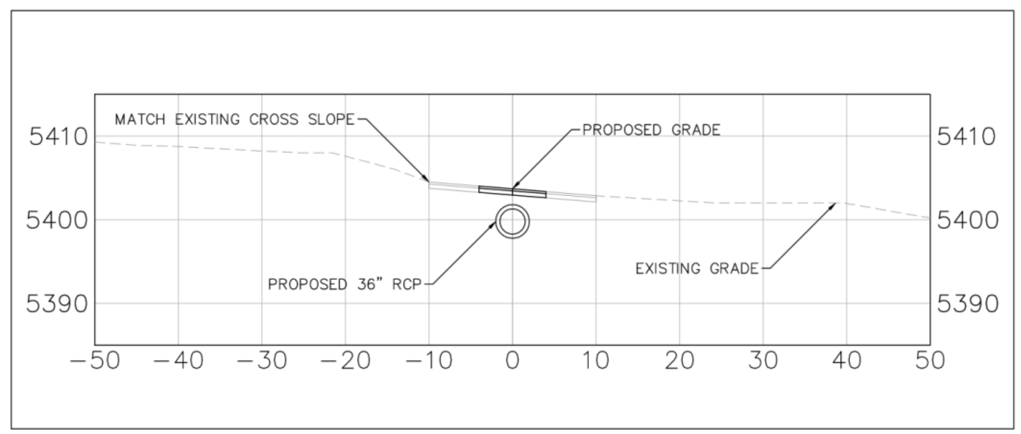


Runoff from north of Williams Dr impacts lots and buildings on the south side of Williams Dr where the buildings are at a lower elevation than the road. There is an existing ditch that is overwhelmed during larger storm events. This proposed mitigation alternative captures the runoff north of Williams Dr in a grader ditch and routes the flow to the wash to the southwest by a 36'' RCP. The preliminary design and cost estimate are shown on the following pages.

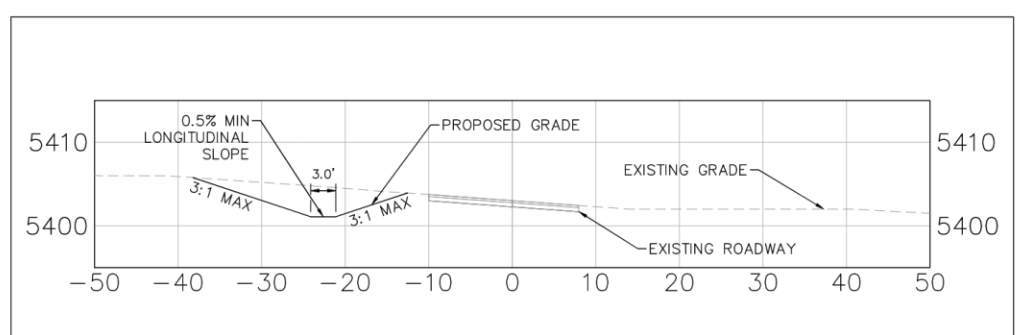
SECTION A—A



SECTION B—B



SECTION C—C



VERTICAL SCALE IN FEET 0 5 10 20

HORIZONTAL SCALE IN FEET 0 5 10 20

NO. | REVISION | DATE

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Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=10'
SCALE (V): 1"=10'
DESIGNED BY: CEO
DRAWN BY: MPF
CHECKED BY: GSB
DATE: 6/30/2020

DIAMOND VALLEY ADMS
WILLIAM DRIVE
PROPOSED

PROJECT NO. 291293002
DRAWING NAME CROSS SECTION
2 OF 2

Kimley»Horn

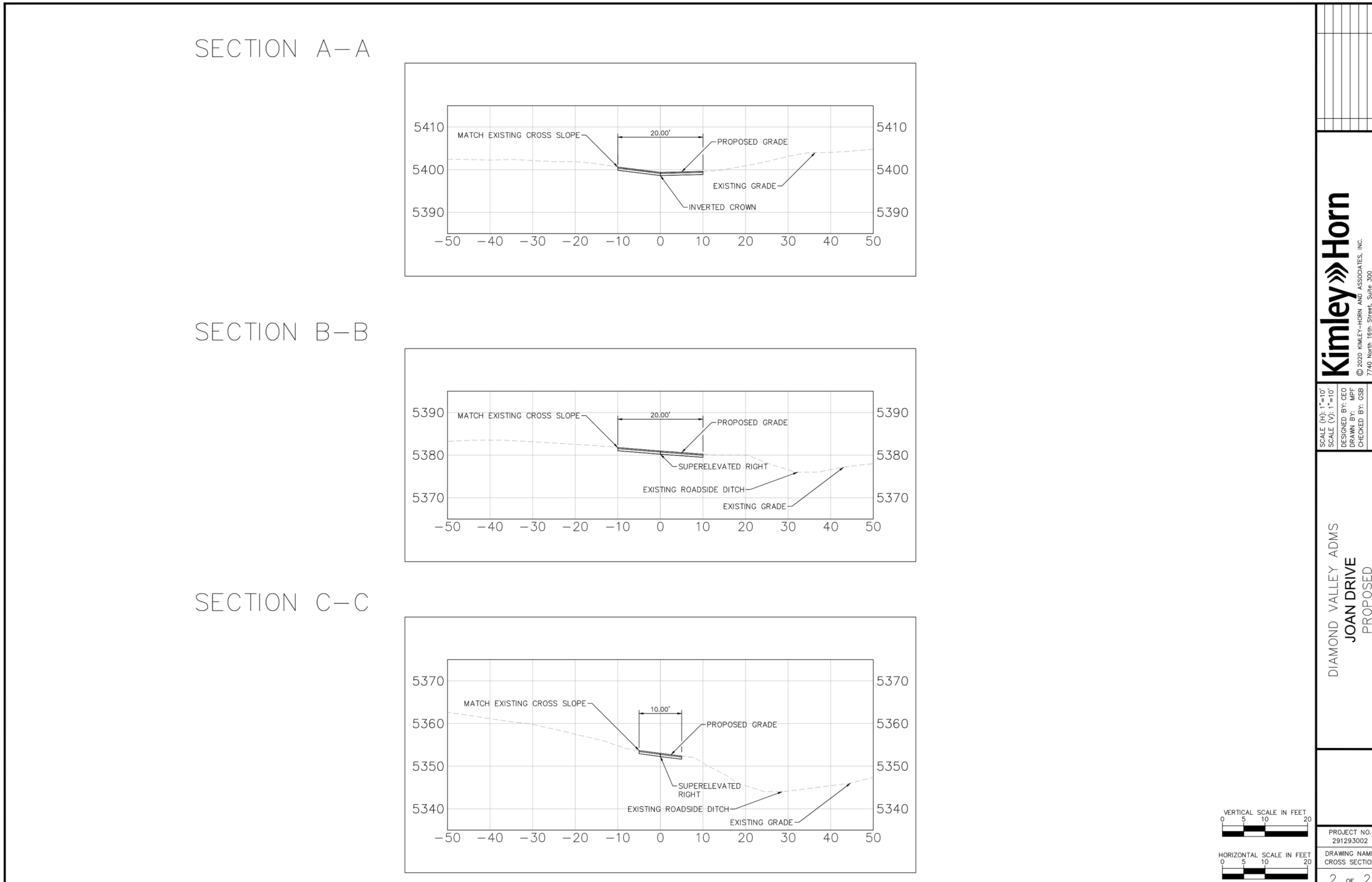
Project: ***Diamond Valley Area Drainage Master Plan***
Location **#7 - William Drive**
Level of Protection **100-year**
Designed by: **CEO** Date: 6/30/2020
Checked by: **GSB** Date: 6/30/2020

Item Description	Unit	Unit Price	Qty	Cost
6" Aggregate Base Course	Ton	$ 30	9	$ 270
3" Asphaltic Concrete	Ton	$ 50	5	$ 250
Backfill and Compact	CY	$ 20	100	$ 2,000
36" Reinforced Concrete Pipe	LF	$ 200	80	$ 16,000
Trench Excavation	CY	$ 50	120	$ 6,000
Ditch Excavation	CY	$ 30	90	$ 2,700
Drainage Easement	SF	$ 1.25	800	$ 1,000
Construction Subtotal				$ 28,220
Removals (5%)				$ 1,411
Miscellaneous Construction Costs (30%)[1]				$ 8,466
Contingency (20%)				$ 5,644
CONSTRUCTION TOTAL				**$ 43,741**
Final Design (20%)				$ 8,748
Permitting (10%)				$ 4,374
PLANNING/DESIGN TOTAL				**$ 13,122**
TOTAL PROJECT COST				**$ 57,000**

(1) Includes Mobilization, Traffic Control, Construction Staking, Quality Control, SWPPP, and Construction Management

9.3 AOMI #10 Joan Dr and Nearby Wash

Runoff flows over and down Joan Dr from an adjacent wash. Joan Dr at this location is a dirt road with at-grade crossings. It is proposed to reprofile Joan Dr, pave the roadway, and include concrete low water crossings to access during wet weather conditions. The preliminary design and cost estimate are shown on the following pages.


SECTION A—A
MATCH EXISTING CROSS SLOPE
20.00'
PROPOSED GRADE
EXISTING GRADE
INVERTED CROWN
SECTION B—B
MATCH EXISTING CROSS SLOPE
20.00'
PROPOSED GRADE
SUPERELEVATED RIGHT
EXISTING ROADSIDE DITCH
EXISTING GRADE
SECTION C—C
MATCH EXISTING CROSS SLOPE
10.00'
PROPOSED GRADE
SUPERELEVATED RIGHT
EXISTING ROADSIDE DITCH
EXISTING GRADE
VERTICAL SCALE IN FEET
HORIZONTAL SCALE IN FEET
Kimley»Horn
DIAMOND VALLEY ADMS
JOAN DRIVE
PROPOSED
PROJECT NO. 291293002
DRAWING NAME CROSS SECTION
2 OF 2

Kimley»Horn

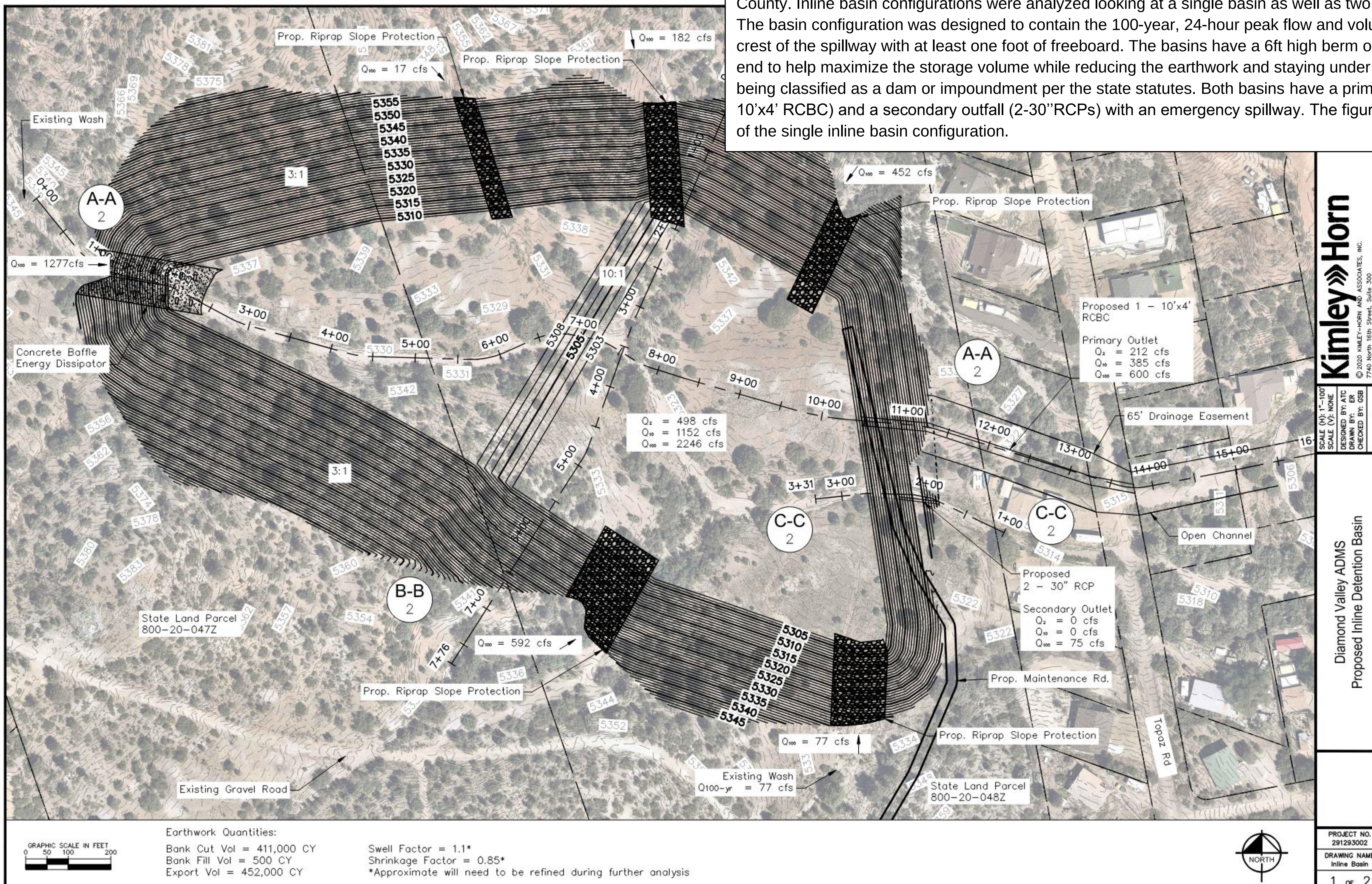
Project: ***Diamond Valley Area Drainage Master Plan***
Location **#10 - Joan Drive**
Level of Protection **100-year**
Designed by: **CEO** Date: 6/30/2020
Checked by: **GSB** Date: 6/30/2020

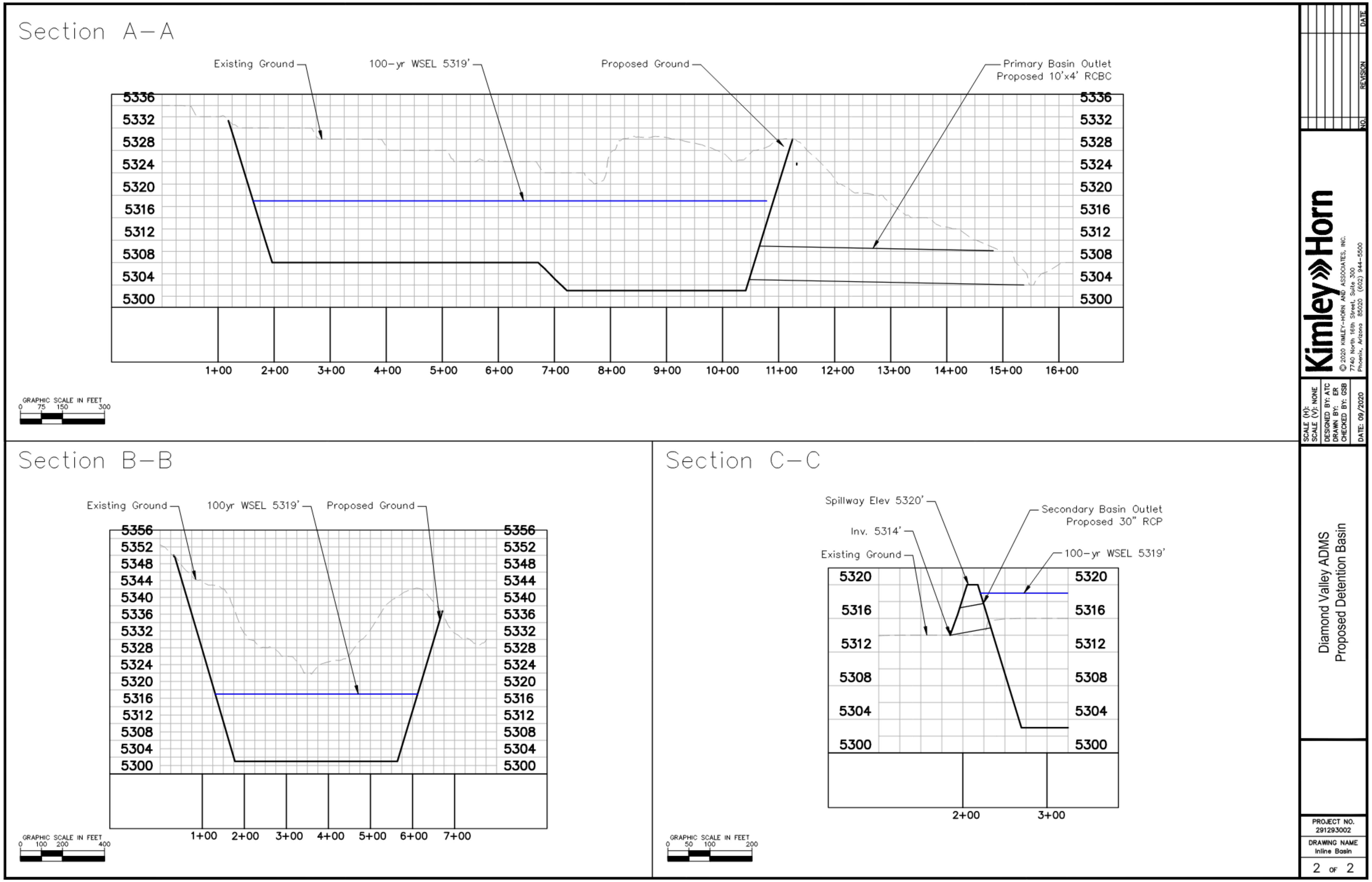
Item Description	Unit	Unit Price	Qty	Cost
6" Aggregate Base Course	Ton	$ 30	849	$ 25,470
3" Asphaltic Concrete	Ton	$ 50	457	$ 22,850
9" Portland Cement Concrete Pavement	SY	$ 100	96	$ 9,600
Construction Subtotal				$ 57,920
Removals (5%)				$ 2,896
Miscellaneous Construction Costs (30%)[1]				$ 17,376
Contingency (20%)				$ 11,584
CONSTRUCTION TOTAL				**$ 89,776**
Final Design (20%)				$ 17,955
Permitting (10%)				$ 8,978
PLANNING/DESIGN TOTAL				**$ 26,933**
TOTAL PROJECT COST				**$ 117,000**

(1) Includes Mobilization, Traffic Control, Construction Staking, Quality Control, SWPPP, and Construction Management

9.4 AOMIs #11 &12 Detention Basin Upstream of Topaz Dr

Detention basin(s) placed upstream of Topaz Dr on the two State Land parcels would reduce runoff coming from the Yavapai Hill subdivision upstream. This improvement would also benefit the roadway crossings for AOMIs No. 6 and the drainage improvement project at Emerald Dr and Hwy 69 currently in design with the County. Inline basin configurations were analyzed looking at a single basin as well as two cascading basins. The basin configuration was designed to contain the 100-year, 24-hour peak flow and volume below the crest of the spillway with at least one foot of freeboard. The basins have a 6ft high berm on the downstream end to help maximize the storage volume while reducing the earthwork and staying under the threshold of being classified as a dam or impoundment per the state statutes. Both basins have a primary outfall (1 – 10'x4' RCBC) and a secondary outfall (2-30''RCPs) with an emergency spillway. The figure on this page is of the single inline basin configuration.




Section A–A
Existing Ground
100–yr WSEL 5319'
Proposed Ground
Primary Basin Outlet
Proposed 10'x4' RCBC
5336
5332
5328
5324
5320
5316
5312
5308
5304
5300
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
GRAPHIC SCALE IN FEET
0 75 150 300
Section B–B
Existing Ground
100yr WSEL 5319'
Proposed Ground
5356
5352
5348
5344
5340
5336
5332
5328
5324
5320
5316
5312
5308
5304
5300
1+00
2+00
3+00
4+00
5+00
6+00
7+00
GRAPHIC SCALE IN FEET
0 100 200 400
Section C–C
Spillway Elev 5320'
Secondary Basin Outlet
Proposed 30" RCP
Inv. 5314'
Existing Ground
100–yr WSEL 5319'
5320
5316
5312
5308
5304
5300
2+00
3+00
GRAPHIC SCALE IN FEET
0 50 100 200
NO.
REVISION
DATE
Kimley»Horn
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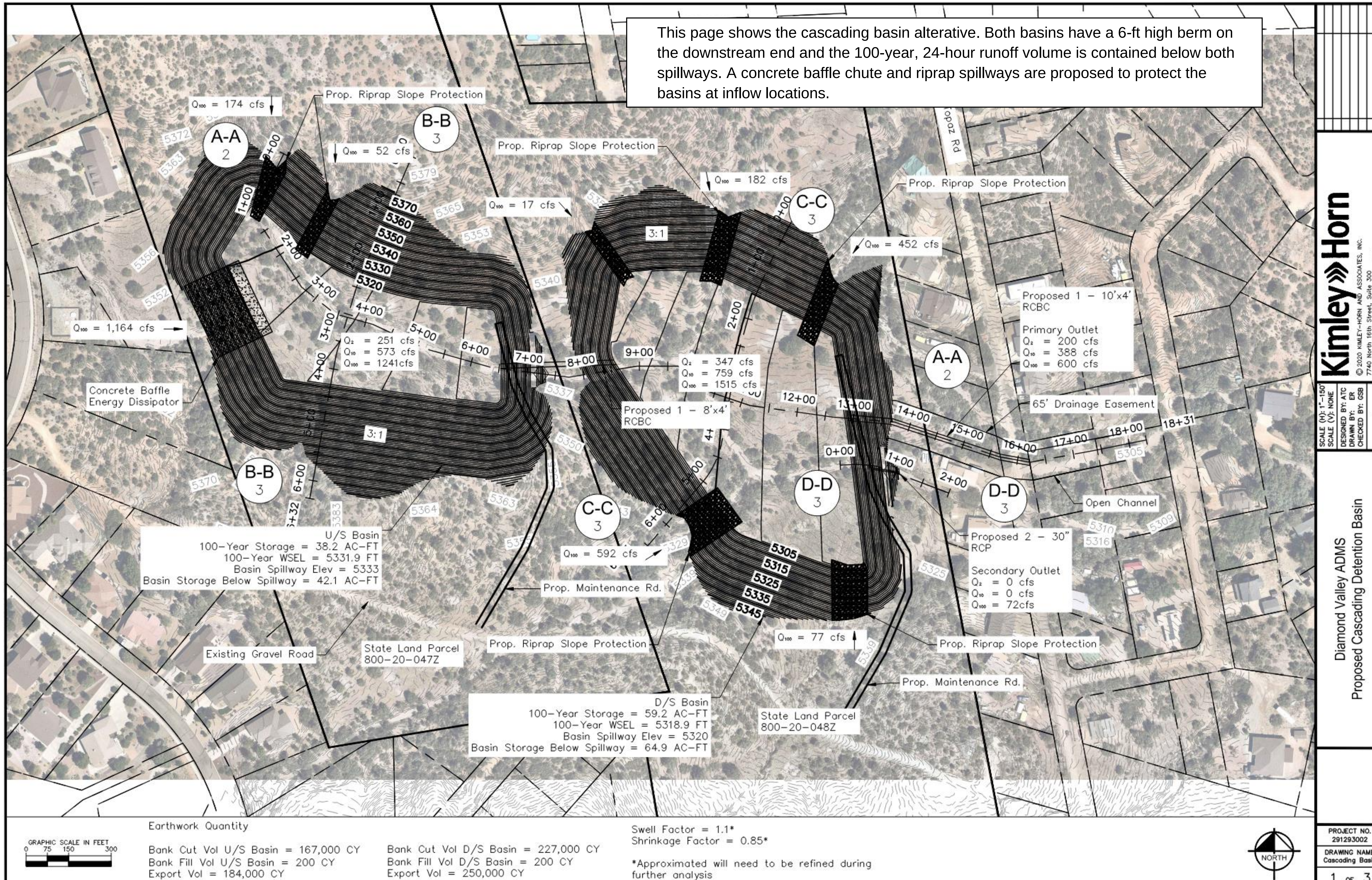
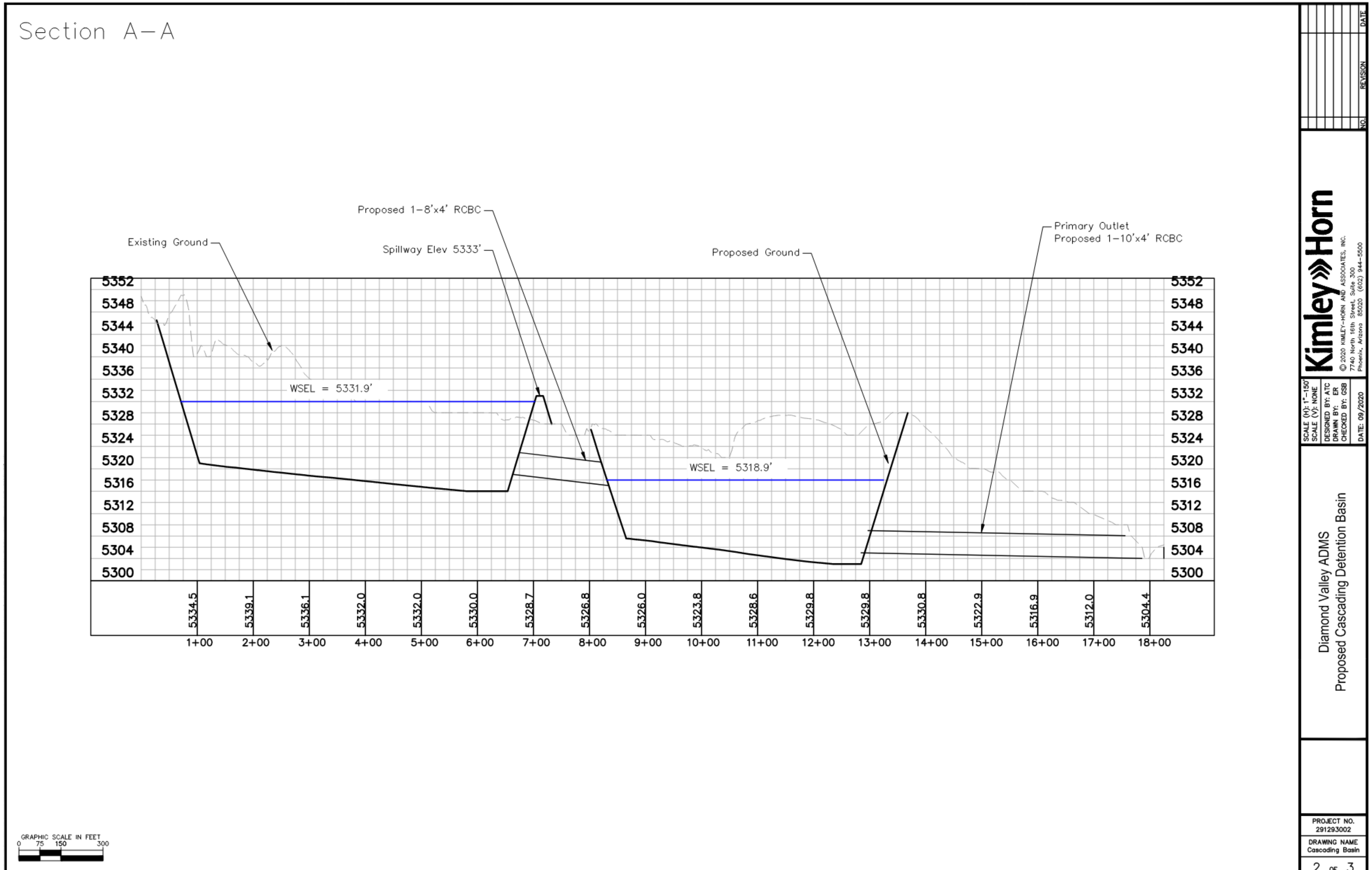
SCALE (H): NONE
SCALE (V): NONE
DESIGNED BY: ATC
DRAWN BY: ER
CHECKED BY: GSB
DATE: 09/2020
Diamond Valley ADMS
Proposed Detention Basin
PROJECT NO.
291293002
DRAWING NAME
Inline Basin
2 OF 2


This page shows the cascading basin alterative. Both basins have a 6-ft high berm on the downstream end and the 100-year, 24-hour runoff volume is contained below both spillways. A concrete baffle chute and riprap spillways are proposed to protect the basins at inflow locations.
Prop. Riprap Slope Protection
Q₁₀₀ = 174 cfs
Q₁₀₀ = 52 cfs
Q₁₀₀ = 17 cfs
Q₁₀₀ = 182 cfs
Q₁₀₀ = 452 cfs
Q₁₀₀ = 1,164 cfs
Q₂ = 251 cfs
Q₁₀ = 573 cfs
Q₁₀₀ = 1241cfs
Q₂ = 347 cfs
Q₁₀ = 759 cfs
Q₁₀₀ = 1515 cfs
Q₁₀₀ = 592 cfs
Q₁₀₀ = 77 cfs
Concrete Baffle Energy Dissipator
3:1
Proposed 1 – 8'x4' RCBC
Proposed 1 – 10'x4' RCBC
Primary Outlet
Q₂ = 200 cfs
Q₁₀ = 388 cfs
Q₁₀₀ = 600 cfs
65' Drainage Easement
Open Channel
Proposed 2 – 30" RCP
Secondary Outlet
Q₂ = 0 cfs
Q₁₀ = 0 cfs
Q₁₀₀ = 72cfs
U/S Basin
100-Year Storage = 38.2 AC-FT
100-Year WSEL = 5331.9 FT
Basin Spillway Elev = 5333
Basin Storage Below Spillway = 42.1 AC-FT
D/S Basin
100-Year Storage = 59.2 AC-FT
100-Year WSEL = 5318.9 FT
Basin Spillway Elev = 5320
Basin Storage Below Spillway = 64.9 AC-FT
Prop. Maintenance Rd.
Existing Gravel Road
State Land Parcel 800-20-047Z
State Land Parcel 800-20-048Z
Earthwork Quantity
Bank Cut Vol U/S Basin = 167,000 CY
Bank Fill Vol U/S Basin = 200 CY
Export Vol = 184,000 CY
Bank Cut Vol D/S Basin = 227,000 CY
Bank Fill Vol D/S Basin = 200 CY
Export Vol = 250,000 CY
Swell Factor = 1.1*
Shrinkage Factor = 0.85*
*Approximated will need to be refined during further analysis
GRAPHIC SCALE IN FEET
NORTH
Kimley»Horn
Diamond Valley ADMS
Proposed Cascading Detention Basin
DATE: 09/2020
PROJECT NO. 291293002
DRAWING NAME Cascading Basin
1 OF 3


Section A–A
Proposed 1–8'x4' RCBC
Existing Ground
Spillway Elev 5333'
Proposed Ground
Primary Outlet
Proposed 1–10'x4' RCBC
WSEL = 5331.9'
WSEL = 5318.9'
5352
5348
5344
5340
5336
5332
5328
5324
5320
5316
5312
5308
5304
5300
5334.5
5339.1
5336.1
5332.0
5332.0
5330.0
5328.7
5326.8
5326.0
5323.8
5328.6
5329.8
5329.8
5330.8
5322.9
5316.9
5312.0
5304.4
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
GRAPHIC SCALE IN FEET
0 75 150 300
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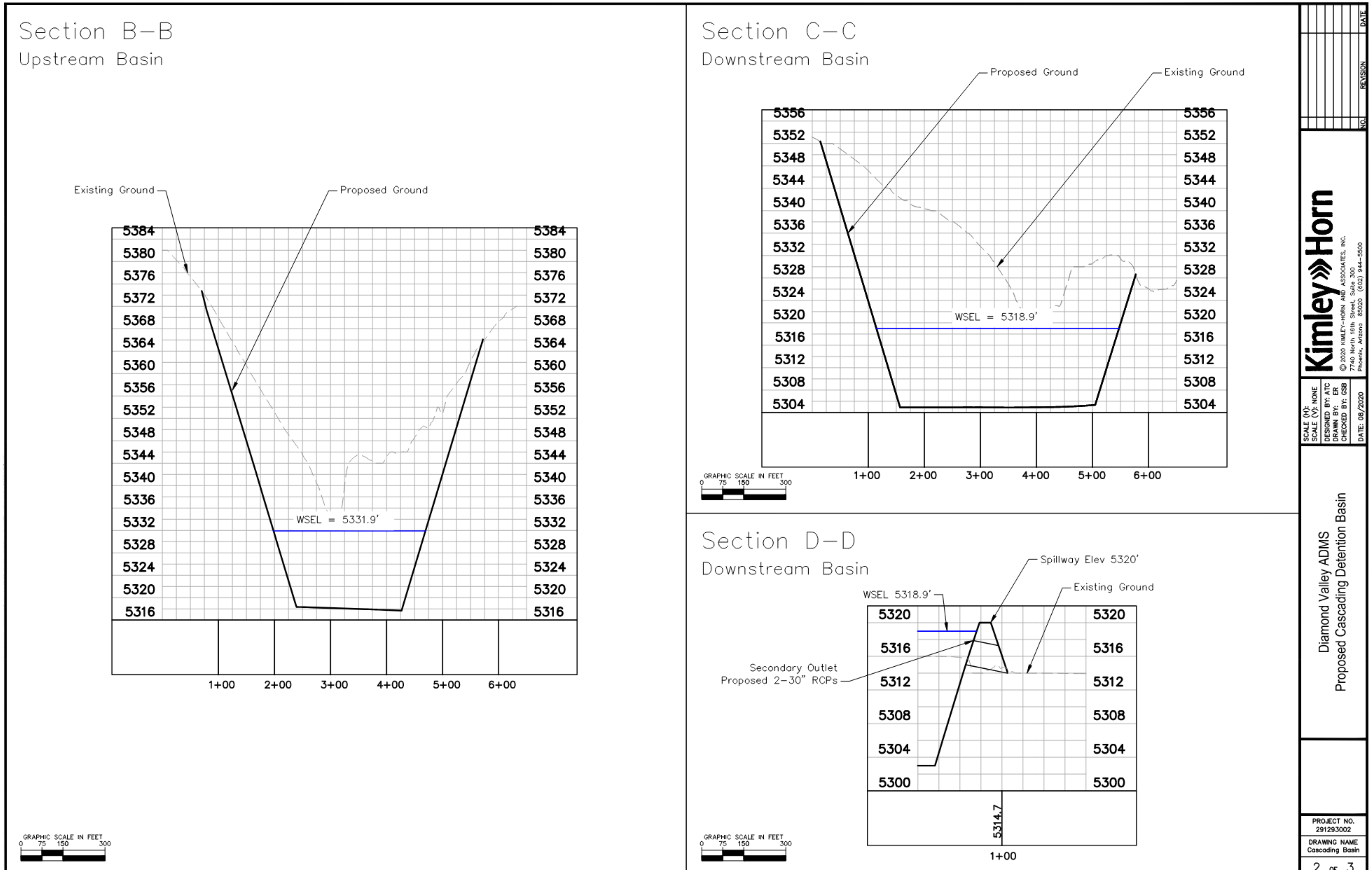
NO. REVISION DATE
SCALE (H): 1"=150'
SCALE (V): NONE
DESIGNED BY: ATC
DRAWN BY: ER
CHECKED BY: GSB
DATE: 09/2020
Diamond Valley ADMS
Proposed Cascading Detention Basin
PROJECT NO.
291293002
DRAWING NAME
Cascading Basin
2 OF 3


Section B–B
Upstream Basin
Existing Ground
Proposed Ground
WSEL = 5331.9'
1+00
2+00
3+00
4+00
5+00
6+00
GRAPHIC SCALE IN FEET
Section C–C
Downstream Basin
Proposed Ground
Existing Ground
WSEL = 5318.9'
Section D–D
Downstream Basin
Spillway Elev 5320'
Existing Ground
WSEL 5318.9'
Secondary Outlet
Proposed 2–30" RCPs
5314.7
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Diamond Valley ADMS
Proposed Cascading Detention Basin
PROJECT NO. 291293002
DRAWING NAME Cascading Basin
2 OF 3

The cost estimates for both basin alternatives are shown in the tables below.

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Project: ***Diamond Valley Area Drainage Master Plan***
Location **#11 - Inline Basin**
Level of Protection **100-year**
Designed by: **CEO** Date: 9/1/2020
Checked by: **GSB** Date: 9/1/2020

Item Description	Unit	Unit Price	Qty	Cost
Maintenance Roadway	SF	$ 15	3,000	$ 45,000
Basin Earthwork (Export)	CY	$ 12	452,000	$ 5,424,000
Concrete Baffle Energy Dissipator	EA	$ 250,000	1	$ 250,000
Storm Drain 30" RCP	LF	$ 190	200	$ 38,000
9" Riprap	CY	$ 150	385	$ 57,750
18" Riprap	CY	$ 180	1,100	$ 198,000
24" Riprap	CY	$ 210	622	$ 130,620
Basin Landscaping (Passive)	SF	$ 1.00	2,243,000	$ 2,243,000
1 - 10'x4' RCBC	LF	$ 1,100	420	$ 462,000
Utility Conflict	EA	$ 30,000	4	$ 120,000
Construction Subtotal				$ 8,968,370
Removals (5%)				$ 448,419
Miscellaneous Construction Costs (20%)[1]				$ 1,793,674
Contingency (10%)				$ 896,837
CONSTRUCTION TOTAL				**$ 12,107,300**
Drainage Easement	SF	$ 1.50	3,200,000	$ 4,800,000
Final Design (7%)				$ 847,511
Permitting (2%)				$ 242,146
LAND/PLANNING/DESIGN TOTAL				**$ 5,889,657**
TOTAL PROJECT COST				**$ 18,000,000**

(1) Includes Mobilization, Traffic Control, Construction Staking, Quality Control, SWPPP, and Construction Management

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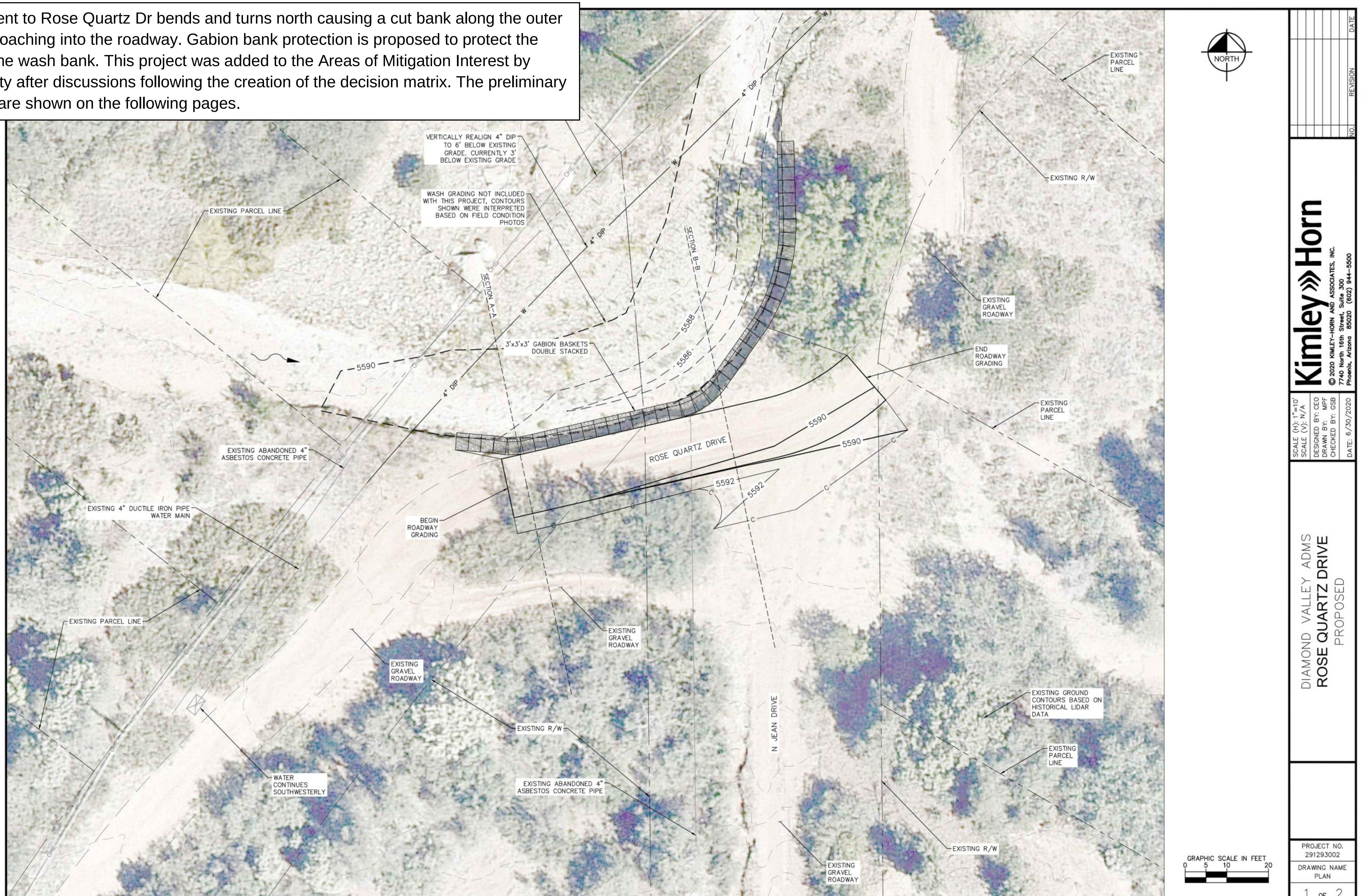
Project: ***Diamond Valley Area Drainage Master Plan***
Location **#11 - Cascade Basin**
Level of Protection **100-year**
Designed by: **CEO** Date: 9/1/2020
Checked by: **GSB** Date: 9/1/2020

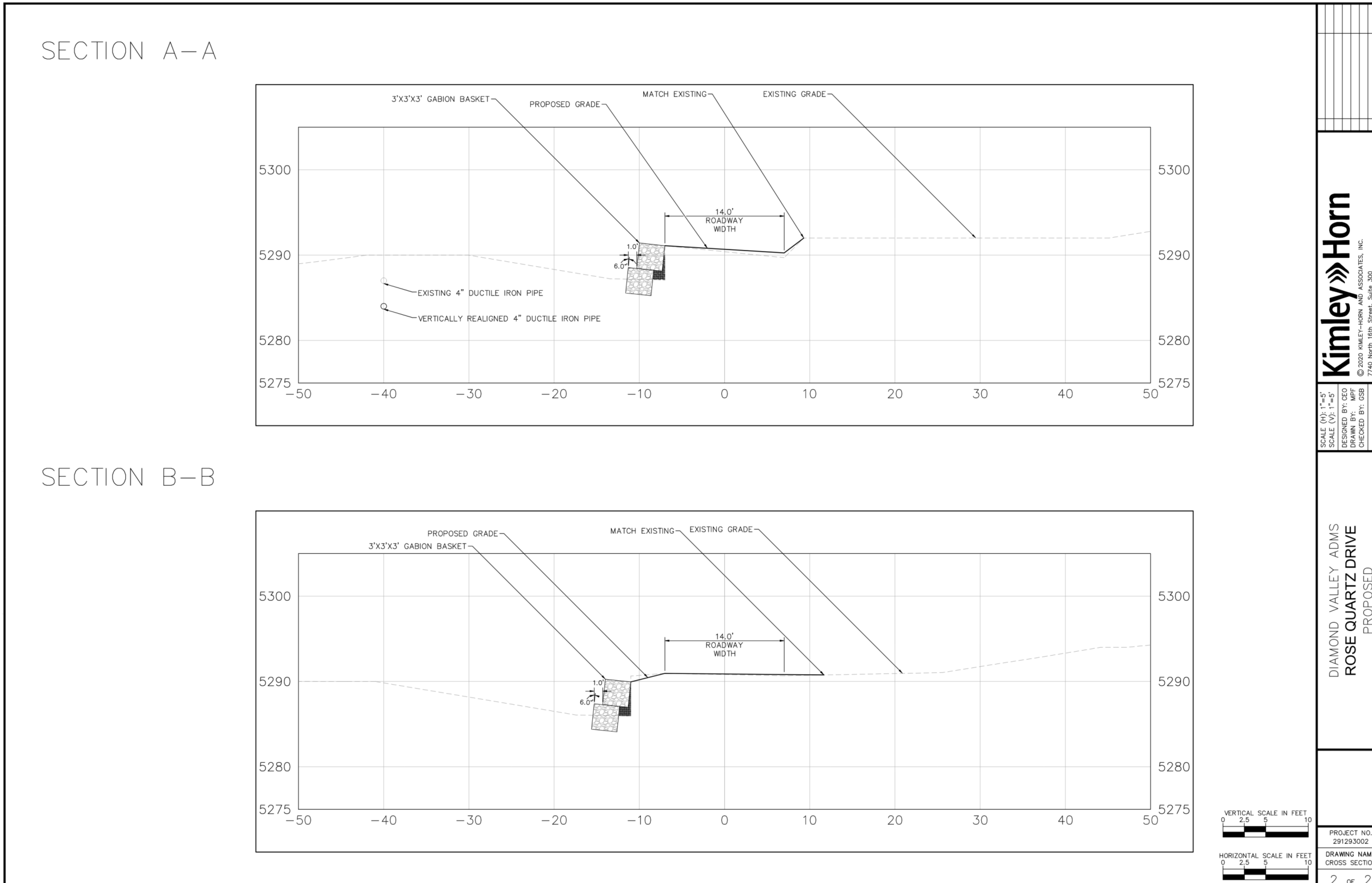
Item Description	Unit	Unit Price	Qty	Cost
Maintenance Roadway	SF	$ 15	15,600	$ 234,000
Basin Earthwork (Export)	CY	$ 12	430,000	$ 5,160,000
Concrete Baffle Energy Dissipator	EA	$ 250,000	1	$ 250,000
Storm Drain 30" RCP	LF	$ 190	8	$ 1,520
9" Riprap	CY	$ 150	540	$ 81,000
18" Riprap	CY	$ 180	1,330	$ 239,400
24" Riprap	CY	$ 210	622	$ 130,620
Basin Landscaping (Passive)	SF	$ 1.00	2,690,000	$ 2,690,000
1 - 8'x4' RCBC	LF	$ 770	400	$ 308,000
1 - 10'x4' RCBC	LF	$ 1,100	420	$ 462,000
Utility Conflict	EA	$ 30,000	4	$ 120,000
Construction Subtotal				$ 9,676,540
Removals (5%)				$ 483,827
Miscellaneous Construction Costs (20%)[1]				$ 1,935,308
Contingency (10%)				$ 967,654
CONSTRUCTION TOTAL				**$ 13,063,329**
Drainage Easement	SF	$ 1.50	3,700,000	$ 5,550,000
Final Design (7%)				$ 914,433
Permitting (2%)				$ 261,267
LAND/PLANNING/DESIGN TOTAL				**$ 6,725,700**
TOTAL PROJECT COST				**$ 19,800,000**

(1) Includes Mobilization, Traffic Control, Construction Staking, Quality Control, SWPPP, and Construction Management

9.5 AOMI #13 Rose Quartz Rod

An existing wash adjacent to Rose Quartz Dr bends and turns north causing a cut bank along the outer bend that is slowly encroaching into the roadway. Gabion bank protection is proposed to protect the roadway and stabilize the wash bank. This project was added to the Areas of Mitigation Interest by direction from the County after discussions following the creation of the decision matrix. The preliminary plan and cost estimate are shown on the following pages.




SECTION A–A
3'X3'X3' GABION BASKET
PROPOSED GRADE
MATCH EXISTING
EXISTING GRADE
14.0' ROADWAY WIDTH
1.0'
6.0'
EXISTING 4" DUCTILE IRON PIPE
VERTICALLY REALIGNED 4" DUCTILE IRON PIPE
5300
5290
5280
5275
−50 −40 −30 −20 −10 0 10 20 30 40 50
SECTION B–B
PROPOSED GRADE
3'X3'X3' GABION BASKET
MATCH EXISTING
EXISTING GRADE
14.0' ROADWAY WIDTH
1.0'
6.0'
5300
5290
5280
5275
−50 −40 −30 −20 −10 0 10 20 30 40 50
VERTICAL SCALE IN FEET
0 2.5 5 10
HORIZONTAL SCALE IN FEET
0 2.5 5 10
NO. REVISION DATE
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SCALE (V): 1"=5'
DESIGNED BY: CEO
DRAWN BY: MPF
CHECKED BY: GSB
DATE: 6/30/2020
DIAMOND VALLEY ADMS
ROSE QUARTZ DRIVE
PROPOSED
PROJECT NO. 291293002
DRAWING NAME CROSS SECTION
2 OF 2

Kimley»Horn

Project: ***Diamond Valley Area Drainage Master Plan***
Location **#13 - Rose Quartz Drive**
Level of Protection **100-year**
Designed by: **CEO** Date: 6/30/2020
Checked by: **GSB** Date: 6/30/2020

Item Description	Unit	Unit Price	Qty	Cost
3' Gabion Baskets	CY	$ 200	84	$ 16,800
Grading Roadway	SY	$ 25	250	$ 6,250
Waterline Reconstruction	EACH	$ 10,000	1	$ 10,000
Construction Subtotal				$ 33,050
Removals (5%)				$ 1,653
Miscellaneous Construction Costs (30%)[1]				$ 9,915
Contingency (20%)				$ 6,610
CONSTRUCTION TOTAL				**$ 51,228**
Final Design (40%)				$ 20,491
Permitting (20%)				$ 10,246
PLANNING/DESIGN TOTAL				**$ 30,737**
TOTAL PROJECT COST				**$ 82,000**

(1) Includes Mobilization, Traffic Control, Construction Staking, Quality Control, SWPPP, and Construction Management

10. Conclusion

The Diamond Valley ADMP developed a detailed two-dimensional HEC-RAS model that was compared and verified against HEC-HMS and FLO-2D models for the Diamond Valley Watershed. Flood hazard areas were defined based on model results and public outreach responses. Areas of Mitigation Interests were defined and prioritized using a comprehensive decision matrix. For the top 5 areas of mitigation interest, preliminary design concepts and cost estimates were compiled. The preliminary design and cost estimates for each Alternatives are intended to inform the County's CIP or provide the basis for grant funding applications and can be advanced as part of design concept reports or as final design projects. These projects will reduce flood hazard impacts for the identified flood prone areas and would increase resiliency in the Diamond Valley neighborhood.

11. References

ASL Consulting Engineers. (1999, June). Daimond Valley Area Drainage Master Plan.

FCDMC. (2016, May). FLO-2D Verification Report.

FLO-2D. (n.d.). Build No 16.06.16.

USACE HEC-HMS. (n.d.). Version 4.3.

USACE HEC-RAS. (n.d.). Version 5.0.7.

Yavapai County. (2015, July 1). Drainage Design Manual for Yavapai County.

12. Appendices – Electronic Files